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As in many areas of modern life, there are two (sometimes) distinct schools of thought in the modding community. On one hand, there are the hardcore performance fanatics who would traverse the Sahara on all fours for a few more MHz, fps, MFLOPS, etc. And then there are the vanity modders, computer users who can appreciate good performance but whose primary concern is that their rigs look tight. Note that we said these philosophies are *sometimes* distinct; some users hunger for a system that is both aesthetically pleasing and as fast as all get-out. We humbly submit that no matter where you fall in the beauty-to-brawn continuum, you'll find plenty of good stuff in this issue.

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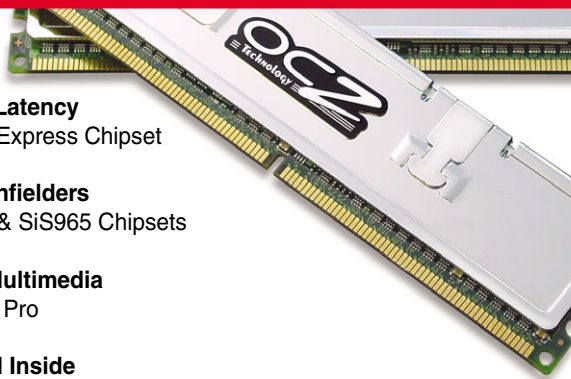
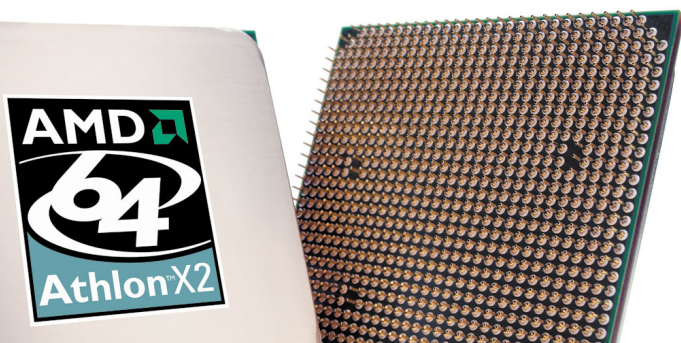
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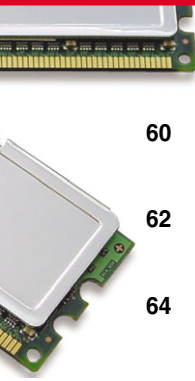
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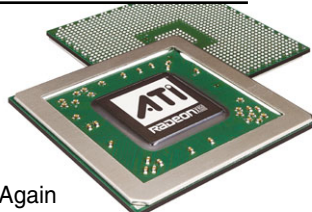


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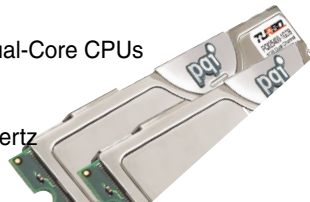
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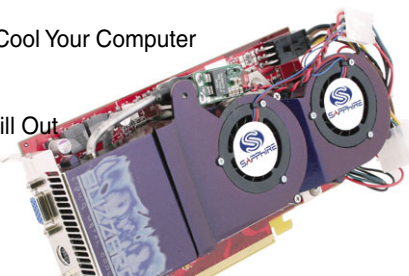
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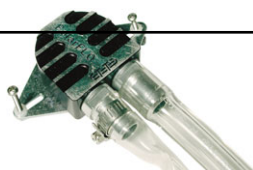
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Fire It Up

Push Your PC To Its Limits



Welcome to overclocking. For every pastime that involves machines, be they planes, cars, or computers, there's a group of people who want to push their toys beyond manufacturers' recommendations. They crave the extra burst of speed that's hidden deep inside their rig, even if it's already a top-of-the-line vehicle or device. Hardcore computer modders don't risk their lives in the sky or on the open road, but they have the same unwavering drive to make their rigs reach new speed horizons.

Of course, few dive into overclocking with an already powerful rig. Even if you own such a beast, you'll probably want to start with a less-expensive computer. If your heart flutters at the thought of your computer's motherboard emitting smoke, you have the wrong rig in mind, but if you're planning to OC a rig that struggled with Win95, you won't learn much. We'll show you how to assess your computers with a power-modder's eye so you can enter the game with reasonable expectations.

Choose Your Weapon

Chances are, your house already has more than one computer. There may be an

older system or two in the garage, or a family rig in the den that handles gaming and your entertainment equipment. If you're planning to OC your only computer and are feeling inadequate, don't worry: Those who can pick and choose will shorten their candidate lists substantially during the next few paragraphs. You can spot the computers that will have the most overclocking potential by assigning each of your systems to one of three categories:

OEM. Dell, HP, eMachines, and other big brands make decent home or office-use computers, but these PCs are almost always overclocking-challenged. The manufacturers often use proprietary parts, which creates two problems. First, many proprietary motherboard BIOSes don't have the setting adjustment features that you'll find in motherboards on computer store shelves. This makes sense when you consider that companies such as Dell try to offer stable PCs that boast long-term lifespans, so they're not interested in features that might throw your system out of whack.

Second, you won't find those proprietary parts on store shelves and you almost certainly can't replace them with standard components. If your motherboard fries, for

example, expect to order the replacement from the manufacturer or distributor (either way, your OC plans for the weekend are shot). Local computer stores probably won't sell the replacement and the manufacturer's restore CD might not let you install Windows on a system that sports a retail motherboard. The PSU is another tricky item, as standard PSUs might not fit in your rig's chassis.

Custom. Local computer builders and national custom builders make great overclocking rigs, even when they're building standard office machines. Sure, some pack their machines with particularly cheap components, but they either use retail parts,



Some BIOSes have a slew of adjustable memory settings, but many have only a memory voltage feature.

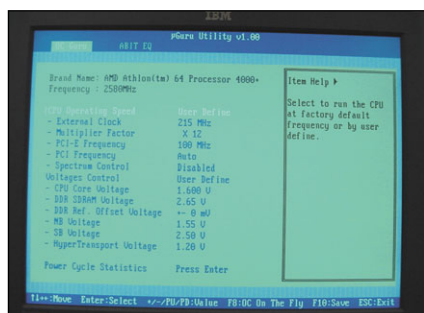
or components that are compatible with retail parts. Thus, if your PSU blows, you can run to your local computer store, buy a new (and perhaps better) model, and get back in the game in a matter of hours.

Another upside to overclocking a rig that has retail parts is that those components will likely have overclocking features built in. ABIT, ASUS, Chaintech, EPoX, Gigabyte, MSI, and a slew of other mobo makers add BIOSes with overclocking-friendly settings to the retail boards.

Gamer. Some custom builders, such as Falcon Northwest, Maingear, and Voodoo cater to gamers and the power-user crowd.

Although high-end custom builders stock their machines with great components, you probably won't enjoy overclocking a top-of-the-line rig as much as you would a middle-of-the-roader.

Why isn't the gamer system at the top of our list? Some custom builders usually overclock the components a little before they send them your way. As with the big brands, they're interested in stability, but they focus more on power. Thus, you'll probably find that your system is already



ABIT's µGuru Utility lumps all of the board's overclocking options into a single section.

near its limits. That's not to say you should write off your gamer rig right away, though; if it's not already overclocked, it may be the most overclockable computer in your house.

Specs, Specs

Once you pick out your guinea pig, it's time to crack open the chassis and size up your rig's overclockability. You can find part model numbers in Windows' Device Manager, but you'll need to get your hands dirty to make sure that your heatsink is up to the task and to clear out dust. You may also spot a few components that you can replace to increase a PC's OCing potential.

Airflow. Heat is a component killer and your system will be more than a little sweaty when you push it to the max. Double-check the cable management situation and spray dust out of the corners and off the fan blades.

CPU. You can OC both AMD and Intel processors. Some AMD processors have an adjustable multiplier, which adds an extra clock speed adjustment option, but Intel processors have locked multipliers.

Make sure your motherboard supports your processor. Although PC builders

match up the processors to the motherboards when they install them in their rigs, amateur builders sometimes forget to pay attention to motherboard and CPU bus speeds. If your motherboard supports an AMD Athlon XP processor with a frontside bus that runs at up to 266MHz but your processor runs at 400MHz, your processor's overclocking headroom is already severely limited by your outdated motherboard. You'll get a massive performance boost by upgrading to a newer mobo.

Heatsink. This is one of the most important overclocking tools in your computer, and unless you're looking at a gamer PC, it's probably ill-equipped to deal with the heat your CPU will soon generate. Most standard systems have aluminum heatsinks, which can handle standard CPU temps, but overclocking pushes most CPUs well beyond normal heat thresholds. If you overclock with an aluminum CPU heatsink in place, it's likely that your system will crash due to heat problems. The good news is you can unlock your rig's potential without performing a major upgrade; a new heatsink is easy to install and will probably lift your computer's OC ceiling.

Copper dissipates heat faster than aluminum, so keep an eye out for aluminum heatsinks with copper cores or, even better, look for an all-aluminum heatsink. We



3D benchmarks, such as 3DMark05, stress test your system for stability and let you gauge performance increases.

should also point out that heavy-duty heatsinks often come with obnoxiously loud fans, but sometimes when you're gunning for top benchmark scores, silence has to take a backseat.

Memory. Your memory's speed rating probably isn't any faster than your system

bus, but if it is, you'll have some headroom to overclock. For example, if your memory is PC3700 DDR, it runs at 466MHz. If your system has a 400MHz bus, you can probably raise the FSB speed quite a bit without running into memory problems.

Motherboard. If you bought your rig from a local or custom builder we've probably tested your motherboard, and we've almost certainly tested your motherboard's chipset. In each issue of PC Modder, we grab the latest processors and motherboards and then overclock them until they collapse (see our Case Studies section for this issue's selection). Thanks to these overclocking reviews and other important information you'll find in the Modder's Library section, you can quickly size up your motherboard's overclocking potential and find the overclocking features in the BIOS.

Power supply. Pay attention to this component. In our experience, the PSU is the device most likely to fail during prolonged overclocking sessions, so watch out for weak and/or low-quality PSUs. If your power supply accompanied a \$35 chassis, you're not looking at a very heavy-duty PSU. We could devote an entire article to power supplies for overclocked machines—so we did. Check out "Power Supply Appreciation" on page 18 for a closer look at PSUs.

Dig Deep

Now that you've assessed your hardware, it's time to climb into the BIOS and take a look at your options there. Although most mobo makers draw from a small pool of BIOS brands, they often add custom screens and features. Many aren't exciting (startup screen tools, for example), but much of the time there are some really useful items (such as multiplier, frequency, and voltage settings controls) that come mixed in with the gimmicky stuff.

Some mobo makers put all of the overclocking settings onto a single screen. (ABIT, for example, adds the µGuru Utility to most of its boards' BIOS settings software. You can enter the µGuru Utility from the main setup screen and access any OC-friendly setting you need.) BIOS screens are a fuzzy, unattractive lot, so the less time you spend flipping through them in search of a particular setting, the better.

We also like the single-screen plan because it keeps your changes right in front of you. If you're troubleshooting a system with a messy, multiscreen BIOS and you've forgotten that you raised the AGP or PCI-E voltage earlier, you won't notice it unless you meander back into that setting's particular section. In a one-screen scenario, you'd notice right away. We'll show you what to look for when you scope out your BIOS. (Here's a hint: Press DELETE during boot up to jump into the BIOS.)

Auto overclock. If you dump takeout into dishes right before your date arrives, you'll like auto overclock tools. Once you enable one of these, it chooses overclocked settings for you, often raising the CPU by a certain percentage for each one. These features are hit and miss, but mostly miss. We've always gotten better results by adjusting the settings manually. Auto overclock tools are pretty safe—they won't choose dangerous voltages, for example—but they can crash your PC, nonetheless.

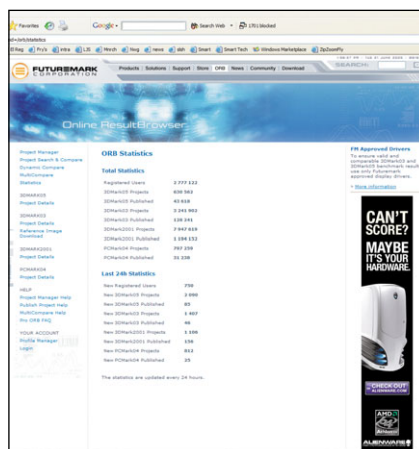
MSI has the most in-depth auto overclock tool we've seen. Its Dynamic Overclocking Technology section lets you choose from such settings options as Private, Sergeant, and Captain, each of which overclocks the CPU by an increasing percentage. We've seen this hit-and-miss feature produce decent overclocks in some situations, but in others it crashed systems at the lowly Private setting.

CPU. You'll spend most of your overclocking time fiddling with the features that affect your CPU, so make sure your system has plenty of CPU toys. The most important settings are the FSB and multiplier fields, but don't overlook the CPU voltage setting, often labeled "VCore."

You'll use the FSB most often to raise your processor's clock speed. Some BIOSes show your projected clock speed as you adjust fields, but if yours doesn't, you can easily determine the clock speed by multiplying the FSB by the multiplier. Keep in mind that actual and effective FSB speeds for today's systems are very different; if, for instance, you're dealing with the AMD's double-data rate technology and your dual-pumped Athlon XP has a 266MHz FSB, you'll need to multiply the multiplier by 133. If your Athlon XP has a 400MHz

FSB, you'll substitute 200MHz. Expect the same situation when you overclock Intel CPUs: A quad-pumped 3.2GHz Intel P4 has an effective 800MHz FSB, which means you'll work with a 200MHz FSB.

An easy way to make sure your math is on the right track is to multiply the default FSB by the default multiplier: the result should match your CPU's default clock speed. If you don't know any of these default settings, look them up in this or other *PC Modder* issues.



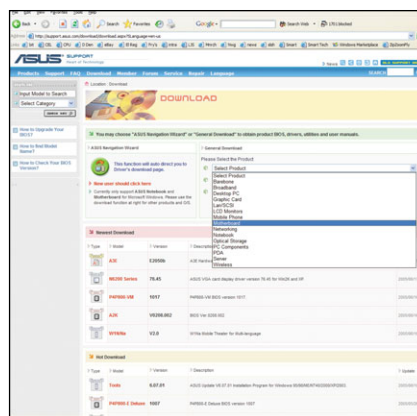
Once you reach your PC's limit, submit your 3DMark05 scores to Futuremark's ORB database (www.futuremark.com) to see how your system stacks up against similar configurations.

Most BIOSes support FSB (and multiplier, if unlocked) settings that are much higher or lower than the defaults, so it's unlikely that you'll need to worry about your board's speed settings limiting your overclock. Power settings, on the other hand, are another matter. If your board's settings don't allow voltages above 1.5V, for example, you can't pump extra juice into a CPU that requires 1.5V by default. And although most systems let you overclock a little without raising the voltage, you'll need to feed a CPU more power if you want to push it to its limits. Trouble is, high voltages can damage your processor, which means you'll need to raise the voltage in small increments and check the results to find your system's power sweet spot. As such, watch out for voltage settings that don't offer increments of as little as 0.5V (smaller, 0.25 moves are even less risky); settings that raise the voltage by percentages

give you little control, making mishaps more likely.

Chipset. Few BIOSes let you increase your system's chipset voltage. We recommend focusing your CPU, graphics, and memory before you turn to the chipset. If you've hit the system's ceiling and think that a little more juice might just stabilize it, give it a try. Generally, boards that allow chipset voltage increases come with chip heatsinks; if your chipset is heatsink-free but the necessary mounting clip holes are nearby, you may want to invest in one.

Graphics. Keep an eye out for an AGP or PCI-E setting. You'll find that some BIOSes let you increase the voltage to your graphics card(s) and manually overclock the frequency. (Many boards offer 1MHz increments that let you inch your way toward glory or destruction.) Note that using these methods can lead to permanent damage to your video card, which may be a little more finicky than your CPU, so you may want to avoid them until you have more experience. In the meantime, we'd



Download the latest chipset drivers from your motherboard manufacturer's Web site. Some video card makers offer drivers from their sites, but many users download the drivers directly from ATI or NVIDIA.

recommend OCing your CPU (and memory if you feel so inclined) and then using Windows-based programs, which overclock your video card in a safer environment.

Health. Don't forget to find your BIOS' PC Health section. Although most health sections don't include adjustable settings, they have tons of information about system temperatures and fan status. If you run into



Mobo makers lure customers with fancy boxes and gobs of accessories, but power users look past glitz to find boards that have the best features: BIOS overclocking options.

problems, this is one of the first places you'll look for troubleshooting info. Keep in mind that system temps are generally calculated based on activity, so don't assume that cool temps in the health section are completely accurate. Use the temps (and other info in the section) as a guide.

Also, the health section may include a feature that controls certain fans, based on your system's activity. Be sure to disable this feature, as you'll want your fans at top speed when overclocking.

Memory. As you can with graphics cards, you can manipulate the voltage to your memory in some BIOSes. And as with graphics cards, you can toast your gear if you're not careful. If your BIOS uses color coding to indicate dangerous voltages, pay attention to them, particularly when you raise memory or graphics voltages. Unfortunately, memory voltage settings aren't as extensive as CPU voltage settings: You'll probably find only 0.1V increments.

Some BIOSes let you adjust other memory settings, such as timings. If you don't see these settings in the main overclocking section, look for them elsewhere; we've seen them in other sections on occasion. If you run across this setting, try lowering the CAS Latency setting, which makes the memory transfer information faster (but can also make the memory unstable). You might also boost performance by lowering other memory timings, if they're available.

Beyond The BIOS

Once you push your system as high as you can without destabilizing it, scour the

Internet for Windows-based video card overclocking software. Unlike the Windows apps that come with some mobos, video card OC programs can sometimes push your card further than you push them through the BIOS. Ray Adams' ATI Tray Tools (www.radeon2.ru/atitray), for example, can automatically overclock graphics cards that boast the ATI Radeon GPU.

And although we prefer the BIOS to any Windows-based CPU-overclocking tool, these programs aren't completely useless: Most of them let you save your custom OC profiles, which means you can run your rig at normal settings and then jump to your preset overclocked settings when you need the extra horsepower. That's handy, especially if you don't want to put undue stress on your PC for everyday computing tasks that don't warrant it.

Rock & Roll

Now that you've given your system the once-over, you know whether you're ready to OC right away or need to upgrade a few components first. Check out this issue's Case Studies section and other mobo-related articles before you shop to make sure your board has the right stuff.

And, of course, back up your data before you turn up the heat. Although you probably won't damage your PC, don't take any chances—we've lost several hard drives during overclocking sessions. If you use your PC to bank online, transfer the software to another PC first. If you fry a part and can't find a replacement for a few days, you'll be glad you planned ahead. **CPU**

by Joshua Gulick

Gear Up

Ready to fire up your system? Before you take your computer for the ride of your life, make sure you have the gear you'll need to make your overclock a success. Here's a list of the top 10 things to have on hand and keep in mind when overclocking:

Make room. Make sure you can easily access your computer's guts. If it normally resides under the desk, pull it out and clear some space on top; you'll need plenty of room when troubleshooting.

Bring provisions. Overclocking and benchmarking takes time. Make sure you have plenty of snacks, delivery menus, and of course, caffeine available for those late-night overclocking sessions. See "The Life" on page 176 for some pointers.

Benchmark often. Although your system may boot up at a certain clock speed, you really won't know whether it's stable (and whether the rig's performance has increased) until you put it through its paces.

Grab a toolkit. It's likely that you'll only need a pair of screwdrivers, but you may want to toss some cable ties, a can of compressed air, and a PSU tester into the mix.

Make a floppy. If you have SATA hard drives in an AMD-based system, you may need a driver floppy to complete the Windows installation. Most motherboards don't include the floppy, so make sure you create one before you overclock (and potentially toast) your system.

Watch your voltage. Increase the voltage only enough to stabilize the system, and then only in the smallest possible increments. For performance boosts, focus on the FSB.

Check your BIOS. Generally speaking, most BIOS updates fix problems, but every now and then a manufacturer will offer one that adds voltage settings or lets users adjust the multiplier (such as the ASUS SK8N).

Record everything. Write down your settings each time you overclock, so you can keep track of what works and what doesn't. When you reach the rig's limits with certain settings, you can consult your chart to see which settings you haven't adjusted yet.

Avoid static. Overclocking in your socks is a bad plan. Make sure you're static free whenever you reach into your case. Some modders swear by antistatic wrist straps.

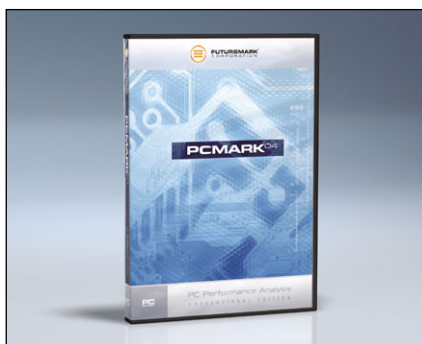
Update your drivers. If you haven't loaded the latest chipset and graphics drivers, you may run into problems that the new drivers might be able to solve. ▲

Your Power-Modding Arsenal

The Tools You Need
To Boost Your PC's Performance



When it comes to PCs, we care most about performance. And for those of us who love to use our computers, we demand as much power and performance out of our PC as we can get. Power modders know that you can get more performance out of



Run a benchmarking application, such as PCMark04 Pro (\$19.95; www.futuremark.com) before and after power-modding your PC.

your hardware by making a few modifications, such as overclocking the components and making sure they are cooled correctly. As with any project, you'll need the right tools for the job.

Preliminary Testing

The best way to evaluate progress when power-modding your PC is to measure the performance of your system before and after any performance modifications using benchmarking software. There are two primary categories of benchmark tests: synthetic and real-world benchmarks. Synthetic tests, such as Futuremark's PCMark04 Pro (\$19.95; www.futuremark.com), measure your computer's speed in accomplishing a variety of tasks and provide a score of accumulated points. Real-world benchmarks offer a more direct approach to testing your computer's performance; you can run a real-world test manually by

timing a process such as processing a batch file in Adobe Photoshop. You can also use a number of PC games to run real-world performance tests. Microsoft's Halo, for example, generates a report of how many fps (frames per second) of its 3D graphics your system can render to give you an idea of how your computer will handle when playing the game. Synthetic tests and real-world tests both have their place, so run at least one benchmark of each type before and after overclocking your system to gauge your system's performance.

Testing the preliminary temperature of your computer is also a good idea before starting. To make sure your computer's cooling mechanisms are working properly, run a temperature monitoring program, such as Motherboard Monitor (mbm.livewiredev.com) or Hmonitor (www.hmonitor.com). Doing so before and after overclocking lets you carefully monitor your system to avoid dangerous



Safety glasses such as the Uvex Bandit (\$7.92; www.uvex.com) protect your eyes without violating fashion.

overheating that can make your PC unstable. Maximum operating temperatures vary from processor to processor; look for your processor's maximum operating temperature in its accompanying documentation or on the manufacturer's Web site.

Safety First

Although power modding may seem less dangerous than case modding, safety should still be your number one priority. Safety for power modders includes making a backup of the data on your computer, just to make sure that you don't lose any important files. You'll also want to make sure that you have the latest version



The Ultra Anti-Static Computer Mat 60x120 (\$39.99; ultraproducts.com) protects your PC and its components from static electricity while you're modding.

of your BIOS and latest drivers for your video card on a CD or flash drive.

If you'll be using a soldering iron, Dremel, jigsaw, or drill at any point during your power-modding experience, make sure to protect your eyes using safety goggles. There are lots of different styles available, so choose a pair that meets both your fashion and performance preferences.



A multimeter, such as the Fluke 189 Data Logging Multimeter (\$399; www.fluke.com), provides information about the voltages going to your computer's components.

Static electricity can be fatal to your PC. A good way to mitigate your risks against static electricity is to use an anti-static mat and wristband. Many mats cover your workstation surface to give you plenty of room to work. Some mats

also come with antistatic wristbands that attach to a metal object, such as your computer's chassis, to provide an electric ground.

What's In Your Toolbox?

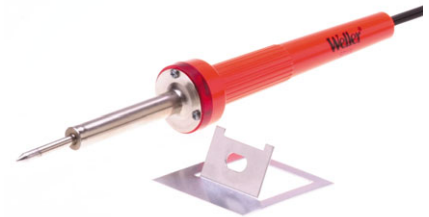
Now that we've covered the bases with regards to safety and precautions, it's time to get started power-modding your PC. The obvious choice when power-modding your PC is to overclock its processor, video card, and/or memory. You can usually do this by changing a few settings in your computer's BIOS. The basic equation for calculating overclocking speeds is multiplier x FSB (frontside bus) = clock speed. Therefore, if your multiplier is 24 and your FSB is running at 100MHz, your effective clock speed is 2,400MHz, or about 2.4GHz. By upping the FSB to 133MHz, your effective clock speed will increase to 3,192MHz, or about 3.19GHz. It's best to move in small steps when overclocking, so don't get overly anxious for faster speeds.

A good multimeter is handy to have around, as it can provide information about how your system is doing before and after you overclock it. Before overclocking, it's a good idea to ensure that your PSU is providing constant, steady voltages to your components while idle and under load. After overclocking, check the voltages again to make sure the power supply remains constant.

Good lighting is an absolute must for power modders. Granted, you may not

need a lot of light to see your monitor if you're only overclocking your processor using the BIOS, but you will need good lighting if you're intending to do any type of hardware mod for performance, such as bridging components.

A soldering iron is especially helpful when modding hardware such as your video card. Get a soldering iron, not a soldering gun, as the latter can get too hot and may not fit in all of the tight spaces of your PC. When using a soldering iron, be sure to have enough solder and flux for the job. Rosin core solder is recommended. When you're finished, remove any remaining flux with a bit of rubbing alcohol. For anyone who's inexperienced with soldering, a lot of practice on scrap parts



A soldering iron, such as the Weller Marksman Iron SP23L (\$10.11; www.cooperhandtools.com), has a variety of uses in power modding.



Get a set of good screwdrivers with a variety of tips, such as the Stanley 11-Piece ProDriver Screwdriver Set (\$25.30; www.stanleytools.com), if you're planning on doing any sort of work on your computer.

can go a long ways to saving a big mistake that costs you later.

Regardless of the reason for modding your PC, one of the staples of your toolbox should be a good set of screwdrivers with lots of choices for tips and lengths. Phillips, flathead, and Torx screwdriver tips can all be handy when opening your case and swapping parts in and out. It also doesn't hurt to have a little box of screws and jumpers that work with your case. After all, you never know when a screw will walk off into Never Never Land.

If you're ready to spring for an all-in-one toolkit, make sure it has needle-nose pliers, wire cutters, Allen wrenches, and a wire stripper. These tools will come in handy both when you're power modding and when you're vanity modding.

Just Chill

Heat plays a major factor in whether an overclocking job is successful; keeping your whole system cool is the goal. If you're looking to get better case ventilation by adding a fan, you'll need a multi-purpose rotary tool (such as a Dremel), a hole saw and a drill, or a jigsaw. Most modders will tell you that the Dremel is



If you're new to modding, a comprehensive toolkit such as the Belkin 65-Piece Tool Kit (\$77.99; www.belkin.com) is a good way to start your collection.



One of the handiest tools a modder can have is a rotary tool, such as the Dremel 400 Series XPR Rotary Tool (\$79; www.dremel.com).



Belkin Multicolor Nylon Tie Wraps, 4-inch (\$5.99; www.belkin.com) help keep your cords from obstructing proper airflow in your case.

one of the best tools they own. With a Dremel you can cut holes, smooth rough edges, and create vents for your case. A variable speed, corded Dremel is best, as it provides the most flexibility and all the power you'll need for a variety of modding projects.

Fans are an easy way to cool your PC and increase the airflow in your case. Adding two case fans, one for intake and one for exhaust, is a good starting point. Using nylon tie wraps, cable sleeving kits, or heatshrink tubing can also help improve the airflow in your PC by keeping cords out of the way.

Using a good thermal compound, such as Arctic Silver 5 (\$8.35 for a 3.5-gram syringe; www.arcticsilver.com), can also give you a few additional degrees of cooling. Always remember that less is more when it comes to thermal compound; a paper-thin application is plenty. Make sure to cover the entire processor because the heat spreader isn't always uniform, which makes some areas heat up faster than others.

Of course, you can also go the active cooling route by installing a water cooling system or vapor phase-change system to cool your PC. These types of cooling systems generally provide more cooling but also require more work to set up and manage. You can even go a step further and get specialized cooling units for specific components, such as your hard drive(s), which will last longer and operate more reliably as a result.



Group your cables together using a cable sleeving kit, such as Vantec's Cable Sleeving Kit (\$11.99; www.vantecusa.com).



A good thermal compound, such as Arctic Silver 5 (\$8.35 for a 3.5-gram syringe; www.arcticsilver.com), is a good way to help keep your processor cool.

Now We're Talkin'

Once you've found some stable overclocking settings, you'll want to make sure that your system will maintain its stability. Two programs you can use to test for stability are GIMPS (The Great Internet Mersenne Prime Search), otherwise known as Prime95 (free; www.mersenne.org), and SiSoftware's Sandra 2005 (www.sisoftware.co.uk) benchmarking suite. Run either of these programs for at least three hours to make sure your PC can handle a heavy load.

After you're confident that your system will remain stable, run the same benchmarking tests that you ran earlier to gauge the results of your overclocking, and enjoy. **CPU**

by Jennifer Johnson

AC
ARCTIC COOLING

Copper Silent 3

alias Copper Lite

The successor of Copper Silent 2



Distributed by

Scythe



Main Features

High Cooling Performance

Copper Lite:		0.48°C/W
Athlon XP3200+ Box Cooler:		0.52°C/W
		◀◀ Better

Extremely Quiet

Copper Lite:		1.0 Sone
Athlon XP3200+ Box Cooler:		2.8 Sone
		◀◀ Better

Lightest Low Noise Cooler (300g)

Suspended Fan

Long Lasting Ceramic Bearing

6 Years Warranty

This cooler is compatible to all Socket A boards. It can also be used on Socket 370 boards if there is a 60 x 78 mm space around the socket.

www.arctic-cooling.com



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Casethetics 101

Give Your PC An Extreme Makeover



Beauty, as they say, is in the eye of the beholder; but what about the very medium itself? Art, even in the traditional sense, shouldn't be confined to a canvas, ball of clay, or slab of granite. True art should also be allowed to flow freely through less pedestrian channels.

If you've been grinding, polishing, painting, or otherwise physically altering your hardware for a while, this probably isn't the article to take your game from that of a casual cutter to a case-modding Michelangelo. Experienced modders should grab their Dremel and head over to our Cut It section on page 157, your one-stop shop with tips, tricks, pics, and first-person accounts from experts who turn destruction into splendor.

Maybe you want your gaming rig to have as much alakazam on the outside as it has on the inside. Perhaps you have an old beige monster lying around in

desperate need of a facelift. Your modding adventure might also take a more practical path: Why buy a bigger case to improve airflow when simply cutting a

blowhole in your current case could do the trick?

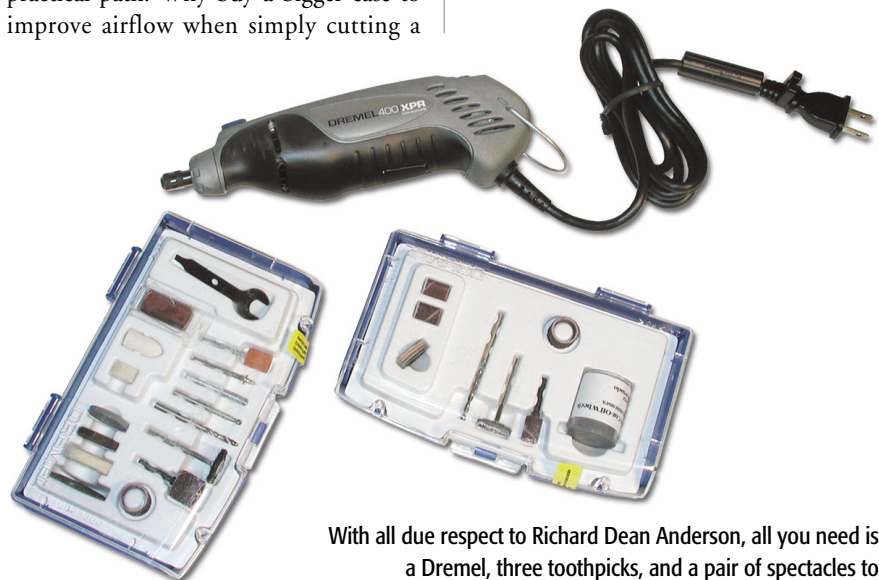
No matter what reason you might have for introducing the top of your case to the whirling fun of a 120mm hole saw, the essential tools for the job remain the same. When you finally work up the nerve to partake in a little constructive destruction, we've rustled up some goodies that you should always have by your side.

Mod Your Case, Not Your Face

We know you're itching to grab your favorite power tool and start cutting, but common sense (and our legal department) compels us to point out a few products that will keep you from winding up on a plastic surgery bloopers reel. Depending on the type of vanity mod you're aiming for, there's protective gear for your various extremities.

You should start with covering up your eyes. After all, modding your case doesn't really do much good if you can't gaze upon the fruits of your labor. This isn't "Minority Report," and you don't get a second pair if you ruin the ones you have. The right kind of eyewear is an essential purchase for any modder.

There are plenty of different types of protective eyewear, and you should select a pair that conforms to industry standards. The ANSI (American National Standards Institute) Z87.1 standard is generally



With all due respect to Richard Dean Anderson, all you need is a Dremel, three toothpicks, and a pair of spectacles to make MacGyver look like a two-bit hack.

considered the benchmark for protection against high-impact objects (read: those bits of shredded steel hurtling toward your face at 150mph). You can also opt for goggles or even a full face shield.



Although it's pretty good at creating general mayhem we'd never endorse, a jigsaw is also a sure-fire way to slice through aluminum.

And if words such as "plasma cutter" pique your interest, you'll also want to make sure your eyewear has filtered lenses with a particular shade number that corresponds with your particular method of metal melting. OSHA (Occupational Safety and Health Administration) has a pretty handy chart that should help you match protective eyewear to the type of cutting device you use. Check it out at www.osha-slc.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9778.

Uvex (www.uvex.com), AO-Safety (www.aosafety.com), and MCR Safety (www.mcrcsafety.com) are just a few of the many manufacturers with a good selection of safety glasses. You can find a sturdy pair of safety glasses for less than \$10, and for the metrosexual modder in you, there are plenty of choices that don't sacrifice style for safety.

Because that rotary cutting tool is capable of generating as much noise as shrapnel, buying a sturdy pair of ear plugs is a sound investment, especially if you plan on prolonged cutting/grinding/destroying sessions. Most earplugs will come with an NRR (Noise

Reduction Rating), which indicates exactly how much noise they will block.

E-A-R (www.e-a-r.com), a subsidiary of Aearo, produces a broad selection of earplugs for your aural well-being. The Classic Plug, for instance, has an NRR 29dB, which should eliminate harmful noise levels. You can also buy reusable earplugs if you know you'll be frequently working around loud tools. Disposable earplugs typically come in packs and sell for a few dollars, and reusable earplugs aren't much more expensive.

You should also consider wearing a mask and gloves if you want to jazz up your plain-Jane case with a candy apple veneer. A good pair of nitrile gloves is excellent because they are resistant to chemicals that can dissolve latex gloves but also give your hands flexibility. Dust and mist respirators provide basic protection and are available at major hardware retailers. But if you have a lot to paint, you might want to call in some heavy artillery. A full-face respirator will thwart about everything under the sun (and give you a better shot at landing that dream job with your local HAZMAT unit).

Here A Cut, There A Cut

Now that we've briefed you on some of the proper precautions to take (remember: logical reasoning, a very popular modding accessory, is always free), we'll



A heat gun, such as this one from Chicago, will work wonders on heat shrink tubing. We can't say the same thing about your hair.

roll out some of the most popular tools of the trade.

Spend about five minutes reading just about any forum thread on case modding,

and you'll likely stumble across the word "Dremel" a few times. Wyatt Earp might have relied on a six-shooter as his weapon of choice, but a vanity modder would never be caught without this popular rotary tool. The Dremel 400 Series XPR (www.dremel.com) is Dremel's latest rotary tool and weighs slightly more than a pound. In fact, our resident off-kilter modding guru, the Mad Modder, liked the 400 Series XPR so much he decided to include one in his insidious toolkit. You can check out his ruminations and rants



Leave that cheap pair of earplugs in when you've finished a job to block out other nuisances, such as siblings, parents, and police officers.

about it and other modding mayhem in "The Mad Modder's Toolkit" on page 36.

Powerful and versatile, a Dremel's strength lies in its ability to perform a number of modding tasks with ease. With the right attachment, you can drill, saw, polish, sand, and engrave, but this is only a sampling of what a Dremel is capable of doing. Dremel's Web site has a treasure trove of accessories that could probably fill an article alone, but you can purchase a Dremel with enough accessories to get your feet wet for about \$80 at hardware stores such as Home Depot (www.homedepot.com) or Lowe's (www.lowes.com).

A Dremel will get you out of many jams, but you'll eventually have to add other tools to your collection as you take on more elaborate projects. A good jigsaw will make cutting through aluminum or steel much simpler, provided you have a blade designed to cut metal. A sturdy corded jigsaw costs about \$50. It will supply a

steady stream of power, but you'll be limited to its cord's length. A cordless jigsaw affords you a little more freedom and mobility, but keeping the battery charged for long projects can be a hassle unless you have a spare you can swap in while you charge the first one.

Cutting a blowhole is a basic modding project that will give you a healthy dose of experience and provide relief for your system's ambient temperature. The most common varieties of fans are 40mm, 60mm, 80mm, and 120mm in diameter. Smaller fans are usually noisier because they have to spin faster to move air; the big boys can accomplish the same task with less ruckus because they're humming along at lower rpms. Decide what size fan you want to install and select a hole saw that is slightly smaller than the fan itself. Avoid the urge to cut a bigger blowhole than you need. It's easier to move to a bigger fan; doing the opposite is a different story.

You may also want a heat gun and soldering iron at your disposal. Sending short blasts of 1,000-degree Fahrenheit heat is awesome in its own right, but a heat gun applies heat shrink tubing with ease and cleans up cable sleeving in a snap. We don't recommend leaving a heat gun on for more than a few minutes at a time or testing it on fingers, small rodents, or in-laws (well, wealthy in-laws). We recently plunked down 20 bucks for a Chicago heat gun from Harbor Freight Tools (www.harborfreight.com).

Soldering irons have been popular from the days of installing mod chips in video



Cordless drills are great for mobility, but heavy use will have you making multiple trips to the battery charger.

games to play "backed up" games, but they can come in handy for other things, too. A soldering iron can reattach a broken capacitor, sparing you from dumping that CrossFire mobo in the circular file, and will generally save the day when you do any electronic modding/repair. If you have a burning (no pun intended) desire to mod your mouse for a glow-in-the-dark look, a soldering iron is essential. ColdHeat's Soldering Tool (\$19.95; www.coldheat.com) is a battery-powered



It's easy to overlook custom fan grilles, but the most discriminating modders will be sure to include (or even craft) them in their projects.

soldering iron fit for intricate jobs. A word of caution: Soldering irons don't produce very pleasant aromas, so it's a good idea to work in a well-ventilated area.

Once you've artistically butchered your case to your liking, turn bow into wow with a glossy new paint job. That white elephant might have been cool back in the days of Doom II and 28.8Kbps modems, but you'll need something with a little more flair for the next LAN party. The basic materials for any case paint job include a spray paint of your choice, a can of sandable primer (we recommend using the same brand for the paint and primer), a sanding block, and wet/dry sandpaper. Don't forget the gloves and respirator we mentioned earlier.

Depending on the sheen you want, you will probably have to purchase different grits of sandpaper. 400-grit sandpaper will smooth imperfections in the original case, and higher grit sandpaper will give your



Better than those laser light shows at the planetarium, fans with built-in LEDs will surely bring back memories of 4 a.m. roulette, cheap buffet food and, well, what happens in Vegas stays in Vegas.

painted case a polished finish. Achieving the perfect paint job can be a time-consuming, arduous chore, but you'll appreciate the breathtaking mirror finish.

Vegas, Baby

We admit a killer case mod with sweet lighting won't get you close to Heather Graham's phone number, but the right products will still leave you feeling like a big winner. Why waste a windowed case on nothing to stare at but drab PCB, plastic slots, and boring black fans? PC lighting projects give your rig a sharp look and can range from something as simple as replacing your chassis fan with one that has fancy, built-in LEDs to recabling your entire machine for that wholesome, Three Mile Island look.

Pulling off a Genesis 1:3 requires a tasty alphabet soup of lighting types. CCFLs (cold cathode fluorescent lamps), LEDs (light-emitting diodes), EL (electroluminescent) wires, and plasma lights help your PC's innards shine like the stars they were destined to be. Because most of these products don't generate a lot of heat, installing them near wires shouldn't create a fire risk. You'll need to account for the extra power the lighting will consume, so you don't overload your PSU.

UV (ultraviolet)-reactive parts will put on a nice show under a black light. Why do you need a black light to set off this extravaganza? Black light bulbs have a coating that filters most light wavelengths,



ColdHeat's Pro Soldering Tool is useful on everything from motherboards to Xboxes... or so we've been told.

emitting purple light and UV-A. (UV-A is ultraviolet light that is less harmful than other UV wavelengths; no sunscreen required.) UV-A light excites a phosphor's electrons to produce a sweet glow.

One example of UV-reactive material is UV paint, such as the paint available at Xoxide (\$14.99; www.xoxide.com). It may look clear under normal lighting conditions, but kill the overhead fluorescent bulbs, bring in a black light, and bask in the colorful glow. UV paint is more expensive, so you'll want to paint as efficiently as possible.

Finishing Touches

It's easy to rest on your laurels after an involved paint job or recabling your system's insides with UV-reactive sleeving, but omitting certain add-ons can relegate your rig from masterpiece to mundane. Custom fan grilles, case badges, and case screws let you express yourself through an allegiance to a particular game or a love of Linux.

Places such as Xoxide, FrozenCPU (www.frozenscpu.com), Directron.com (www.directron.com), eXtreme PC gear .com (www.xpcgear.com), and CrazyPC (www.crazypc.com) have all of the odds and ends to make your PC look heads and shoulders above the rest of the pack.

If you want to feast your eyes on some inspiration, check out "Mod(ern) Art" on page 162, our rogue's gallery of jaw-dropping cases. These faithful modders have spent a considerable amount of time pouring their creativity into their PCs, and the results speak for themselves. With a little time and persistence, perhaps your creation will be featured in our next installment. **CPU**

by Vince Cogley

Call In The Pros

As much as we appreciate the nature of DIY modding, there are some projects that are impossible (or at the very least, infeasible) to complete without a little outside help. Applying an automotive-grade paint job or adding a custom laser etching requires purchasing equipment that really only makes sense if you're planning on modding many cases.

Depending on your sloth factor, having a professional mod job can range from a simple task to simply buying a pre-modded case. Manufacturers such as Lian-Li (www.lian-li.com), Cooler Master (www.coolermaster.com), Thermaltake (www.thermaltake.com), and Antec (www.antec.com) have a slew of cases with every combination of windows and blowholes a budding modder could ask for. Obviously, these cases may not have the same unique feel as a case you modded yourself (think 1,000-person LAN parties), but it definitely cuts out a lot of the time and guesswork associated with doing the dirty work yourself. Depending on the number of features you want and the material of the case itself, expect one of these cases to cost between \$50 and \$200 on average. Zalman's (www.zalmanusa.com) TNN 500A, a completely noiseless case, will set you back at least a grand.

If you're looking for a custom paint job, you have a few options if you want to turn over your case to a seasoned vet. Some services charge an hourly rate for a paint job, while others often have flat rates for preselected cases and designs. For example, PCModz.com (www.pcmodz.com) has a library of different designs the company will hand-airbrush onto one of its cases. You can add case badges, logos, and other options at an additional cost. At the time of this writing, PCModz.com offered custom air-brush painting for \$169 per case. For another \$60, you can submit your own design.

It's easy to spruce up a case window with an etched applique for a few bucks, but this is almost the vanity modding equivalent of an iron-on patch. For a design that is as permanent as it is personal, you could turn to a waterjet cutting service. For example, Custom-WaterCuts.com (www.customwatercuts.com) specializes in cutting custom case windows according to your specifications. Prices vary according to the type of design you want, but the waterjet is so strong it can slice through material up to 10 inches thick. Because the waterjet can cut any material from rubber to titanium, it's conceivable that for the right price, you can have your own custom waterjet-cut case.

If money is no object, you can pay someone to build you a complete system from scratch. MNPCTech.com (www.mnpctech.com) took an AMS case and molded it into the fancy duds of our screaming CPU Stingray featured on pages 92 and 157. At a rate of \$40/hour for labor plus the cost of supplies, MNPCTech.com gives you a veritable buffet of case modding choices from automotive-grade case painting (according to the Web site, most paint jobs range between \$125 and \$600, based on the complexity of the design), case soundproofing, and electrical wiring (case lighting and custom switches). MNPCTech.com calls its creations works of art; take one glance at the Stingray and you'll see why.

Although there are companies that focus on PC case modding, it's not a bad idea to search your local Yellow Pages for any businesses that have the necessary equipment for an uber-sweet modded PC. You might draw a few snickers from an automotive paint shop, but you could end up walking out with a custom painted case for a lot less than you'd pay online. Plus, you can't beat the shipping charge. Depending on the size of your stomping grounds, it might be worth hunting around for someone willing and able to perform a laser etching or waterjet cutting. ▲

Power Supply Appreciation

Lauding Your PC's Forgotten Component



The fable of the ugly duckling proves that even when you get dissed, there's always a chance that you can come back and make your mark on the world. In the realm of computer components, there's rarely been a duckling as hideous as the power supply unit, but now, thanks to the emergence of at-home power computing and PC modding, PSUs aren't just en vogue; they're almost, well, beautiful.

Your ultra-speed CPU is the heart of your computer, and a motherboard is your computer's nervous system. Yet as important as these components are to efficient computing, they're useless without a reliable PSU. But PSUs are typically pushed aside by computer sellers who use sexy CPU, RAM, or hard drive specifications to lure buyers.

The bad news is that getting stuck with a low-quality PSU might cause

your system to exhibit erratic behavior or, worse yet, that PSU might actually contribute to the slow death of your components. The good news is that by educating yourself on the critical fundamentals of PSUs, you can invest in a better product that will help you keep a high-powered system running smoothly for years.

It Only Takes A Spark

Your PSU's main purpose is to take electricity from a wall outlet and convert it into the kind of power that your computer can safely use. Your home's electrical system provides power in AC (alternating current) form, so the PSU must turn this into the DC (direct current) voltages that are digestible by home electronics.

Your PSU doesn't provide just one type of voltage. Instead, it provides three main voltage levels, including +3.3V, +5V, and +12V. Your PC's internal circuits use the +3.3V and +5V signals, while the +12V line goes to motors like those used to spin optical disc drives and hard drives. A high-quality PSU provides each of these voltages at precise levels to make sure each PC component receives just the right amount of power.

Like all PC components, PSUs have evolved to meet changing hardware specifications. Contemporary PSUs come in several shapes and sizes to let them slip inside a variety of case sizes, but the most popular PSU form factor is based on the ATX standard that Intel introduced in 1995. PSUs adhering to the ATX standard measure 86 x 150 x 140 mm (HxWxD), and usually these products have an 80mm fan to help keep internal parts at normal operating temperatures.

PSU power ratings also change with the times. Just a few years ago, few systems needed a PSU that provided more than 250W of output power. These days, 250W is barely enough to run a fully loaded multimedia machine, and enthusiasts often require PSUs that can pump out 400W, 500W, or even higher wattages that help power cutting-edge

processors and super-fast hard drives.

PSU Problems

Low-quality PSUs might provide necessary power, but they might also cause a range of PC problems. For instance, PSUs of questionable quality are often incapable of providing steady, clean power to your computer's components. Power fluctuations can cause any of your computer's parts to malfunction, and in some cases, power irregularities can also damage your components.

In addition, as you add more parts to your computer, you apply more stress to the PSU and increase the chances of intermittent problems that are difficult to pinpoint. In these situations, PSUs are often to blame, but because users rarely associate problems with their cheap PSUs, they often waste money by replacing other parts instead.

Poorly built PSUs also often run at higher temperatures than their better-engineered cousins, and as a result, they can cause your system as a whole to run hotter. Over an extended period of time, that extra heat can shorten the lifespan of your other components.

You should consider all of these possibilities when you're considering an inexpensive prebuilt system or a low-cost case that's bundled with a power supply. You can bet that the manufacturer is cutting corners somewhere, and one of the most common ways to slash costs is including an inferior PSU.

Power-Hungry PC

A high-quality PSU will seem even more important when you start to recognize just how much electricity your system needs to run nominally. The individual components that make up

your PC don't consume much power on their own. Put them together in a working machine, however, and your power requirements rise dramatically. By approximating the power needs for each part of your PC, you can make educated guesses on the amount of power you'll need for your system as a whole.

You might immediately wonder why there's guesswork of any kind involved, if power concerns are so important. The answer is that getting accurate power readings of your computer's parts isn't easy. Software utilities that claim to measure power levels are wildly inaccurate and provide ballpark figures at best. You can invest in a multimeter that will help you measure voltage, but even with one of these expensive tools you'll still have to do some math to figure your PC's power usage.

Component manufacturers often complicate the power estimation process by providing sketchy or flat-out incomplete specs with their products. Without wattage data, you're left to calculate power needs on your own. Fortunately, even products with poor documentation usually have a sticker displaying basic power information. You can use this information to approximate the power

consumption of your machine.

We used the label on an optical drive to demonstrate how you can find the electrical requirements for an individual device. Our drive indicated that its power needs were 5V at 1.2A (amps)/12V at 1.5A. We multiplied the 5V by 1.2A and the 12V by 1.5A and then we added the numbers together for a total of 24. That's not 24 volts or amps, of course, but 24 watts. This doesn't mean that the drive always uses 24 watts, but it

does give you some idea of how much power this device is capable of consuming. Repeat this exercise for each part of your system and you'll get an idea of how much wattage you need to power your system reliably.



Software utilities are inaccurate for gauging power levels in your PC. You can perform some simple math to get a good idea of the power needs in your machine.

PC Power Needs

Modern PCs are power hogs, but it's not always obvious which components are sucking down the most electricity. This chart offers power-consumption estimates for the most common PC parts, so you can make better PSU buying decisions.

Component	Wattage (approximate)
Motherboard	20 to 30W
CPU	70 to 120W
RAM Module	20W per 256MB
PCI Card	5 to 10W
Video Card	25 to 50W
Hard Drive (SATA)	10 to 15W
Optical Drive	10 to 20W
Case/CPU Fan	2 to 5W
Keyboard	1.5W
Mouse	1.5W
USB Devices	5W
FireWire Devices	5 to 10W
Floppy Diskette Drive	5W

It's often easy to find the power requirements of devices such as optical drives and CPUs, but you might have a more difficult time finding power usage figures for memory modules, motherboards, and other crucial components. See the "PC Power Needs" sidebar in this article for broad power guidelines that will help you round out your power-usage estimate.

PSU Jargon

Understanding your computer's power needs will help you find a PSU based on its wattage requirements. Getting a better grip on the terms often used in PSU specifications will take you one step closer to having the knowledge you need to make the perfect PSU purchase.

One common PSU specification is MTBF (mean time between failure), which is the number of hours the unit should work until it malfunctions. Many PSUs have MTBF ratings that fall somewhere from 80,000 to 300,000 hours. Those large numbers clearly aren't based on real-world tests; instead, manufacturers make lifespan estimates based on the failure rates of the PSU's individual parts.

Overvoltage protection is the way your PSU shields devices from power spikes. If the power levels in your home suddenly jump higher than normal, your PSU should stop the extra voltage by shutting down or by dampening the signal, thus protecting the end component, such as your motherboard, from being zapped. The overvoltage protection kicks in once power exceeds a certain voltage; for instance, some PSUs will stop the signal if the 12V power exceeds 14.3V or if the 5V power exceeds 6.2V.

Efficiency refers to the ratio of input power to output power. In a perfect world, PSUs would be 100% efficient, but during the AC/DC power conversion, a sizable chunk of power dissipates

strain one of the output voltages. If you multiply each voltage times its maximum amperage and then add the results, you'll see in most cases that the total wattage is much higher than the PSU's advertised wattage. This just indicates that your PSU can't provide maximum power on each voltage simultaneously, which is true for every PSU.

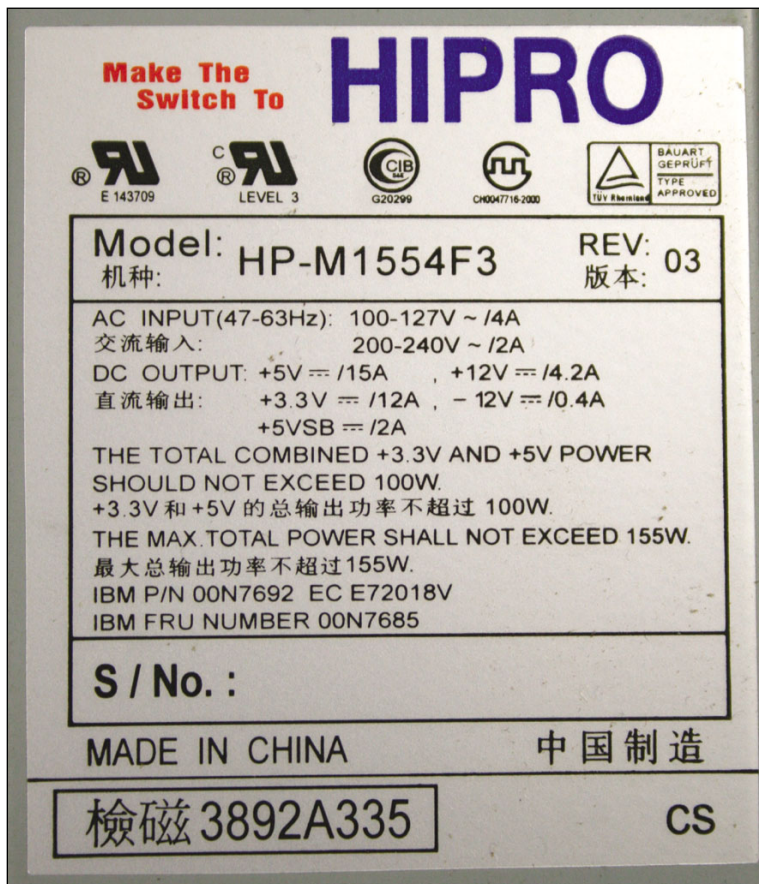
Power Good Signal

With many PSUs, you'll also see a specification for the Power Good signal. As you start up your PC, your PSU needs a moment before it starts producing the kind of voltages your PC's components need to operate properly; it can take up to a half a second or even longer for power levels to stop fluctuating and then even out at levels appropriate for your PC. If your computer were to attempt to start up before this PSU stabilization occurs, there's a possibility that you'd experience some odd booting problems, so it's

a good thing that, without this go-ahead from the PSU, your motherboard won't even begin routing power to any of your PC's many components.

All PSUs have to send a Power Good signal, of course, but not all of them perform this job as they should. Good-quality PSUs always delay the Power Good signal to the motherboard until voltages within the computer level off following the initial electrical surge that occurs when you turn on your PC.

Cheap PSUs, on the other hand, immediately try to supply power to the system and can cause the CPU to start up too soon, which in turn can potentially cause corruption in your system's startup processes. A



Many PSUs come with skimpy spec sheets. Fortunately, most products include labels with stickers that detail output voltage levels.

in the form of heat. Most PSUs are about 65% to 85% efficient. Higher PSU efficiency means less wasted electricity and less heat inside your PC's case, so buying an efficient PSU is important, but a PSU that's reliable and stable is still more important than a PSU that's extremely efficient.

A PSU's output refers to the current (expressed in amps) that it can supply. PSU manufacturers often list these current values as separate amperages for all of the PSU's voltage levels. These numbers can help you find the PSU's maximum power potential and also help you determine how many devices you can connect to the PSU before you begin to

good-quality PSU waits at least 0.1 of a second to send the Power Good signal.

A well-designed PSU will also kill the Power Good signal if there's a significant power surge or some other power glitch that could potentially cause a problem. Such a PSU won't restore the Power Good signal until the power source becomes stable again. If you've ever been running your computer when your home's lights flicker, and then your computer restarts, you've witnessed this PSU feature in action.

Wattage Confusion

Of all the power supply specifications you'll see bandied about, none causes more confusion than the wattage ratings manufacturers print on their boxes and inject into their products' names. For one thing, buying a PSU based solely by its advertised wattage is a little like buying a computer simply because it has the fastest processor on the market—without a solid motherboard, quality RAM, and other worthy components, that fast processor just goes to waste. And the wattage ratings that PSU makers list aren't really intended to be the final word in their products' performance, in any event.

So when you see that 400W sticker on the PSU you're perusing online, know that it's really just a quick way for the manufacturer to convey the unit's approximate wattage to you. Look more closely at that same sticker and, in most cases, you'll find more detailed information on the PSU's power at specific voltages. For example, you might see that the PSU provides 220W of combined power at the +3.3V and +5V lines; these numbers are a way to get much more specific information on the kind of performance you should expect from a particular product.

One last pointer on PSU specifications: If the manufacturer doesn't list power specs for the PSU's various voltages, keep in mind that your PSU's total wattage is probably about 20 to 30 watts less than the advertised rating. This trend is especially true for higher-wattage (400W and greater) units.

More wattage concerns. As you're shopping for a new PSU, you'll want to keep in mind that some devices draw

more power at specific voltages than others. For example, let's assume you're using a 300W PSU that provides 12V power at a maximum of 15A. With our simple formula of multiplying the voltage (12) by the amperage (15), this means your PSU can provide about 180W of 12V power, not 300W. Because power potential is limited at each voltage, it's not advisable to add so many 12V-dependent devices that you stress your PSU.

What's more, PSUs are most reliable and provide the steadiest power when they provide only about 30% to 70% of their power. That's why when you're building your own system, it's best to buy more PSU muscle than you need. You'll spend more money, but your computer will run more reliably, and you'll have more confidence that your PSU isn't causing peculiar PC behavior. And your investment will hold up over time, because PSUs withstand obsolescence much better than typical computer components, such as CPUs and RAM.

Power Finale

With the era of at-home power computing well underway, it's good to see oft-forgotten components such as PSUs finally getting their due. As serious users demand better products, manufacturers that cater to PC enthusiasts are taking every possible step to exploit new PSU marketing opportunities, offering models with more power and visual appeal. Better yet, these companies are going out of their way to create PSUs that match the high quality of today's motherboard's and CPUs.

So don't underestimate the importance of your PSU. Knowing more about PSUs and power fundamentals will help you make better buying decisions for your computer and also help you zero in on quirky problems that your system might develop due to power difficulties. Stick with high-quality brands and make sure you have enough power to satisfy your PC's hunger for electricity, and your computing sessions will be more efficient for years to come. **CPU**

by Nathan Chandler

I Have The Power!

Enermax's Noisetaker 600W (www.enermax.com.tw) is capable of powering both desktop PCs and dual-processor workstations. It comes loaded with two fans (and manual and auto fan speed controls) and, best of all, two split PCI Express connectors so you can power two high-end graphics cards.



The Turbo-Cool 850 SSI from PC Power & Cooling (www.pcpowercooling.com) has a peak power load of 950W, making it suitable for dual-video PCs or even workstations with four, count 'em—four—CPUs. It also has a whopping 15 drive connectors, six of which are SATA.



The SkyHawk Audio Stand-By series PSUs (www.skyhawkgroup.com) provide standby power that let you play CDs and DVDs without booting your computer. There are three versions, starting with the 440W basic unit to the 640W monstrosity. ▲

Basic Benchmarking

Put Your System On The Dyno



You've spent hard cash on parts and put in hard time tweaking settings. Now you want to see some return on your investment.

Were the changes you made to your PC worthwhile? In other words, have you bolted on a supercharger or merely a fat muffler that fools about as many people as a comb-over hairdo? Time to take your system for a test drive.

Benchmarking can tell you whether you've gained (or lost) any performance in your system, but more importantly, it can tell you how much. Your new graphics card may feel faster, but how much better is it, really? Is overclocking your CPU, GPU/VPU, or RAM worth it? Will more RAM actually help the games and apps you use?

In brief, benchmarking means quantifying something about the way your computer does a task. That usually means pinning down how fast it can run an app or game, or move data from one medium to another.

This definition might make your eyes glaze over, but the first time you verify

that you just doubled your Doom 3 frame rate with a new video card, you'll see what we mean. And when your 3DMark05 score surges past your buddy's thanks to a quick—and free—overclock, benchmarking will get into your blood.

Soon, you'll be doing before-and-after tests to try out every new device and tweak and you'll figure out which specs are really important when you're tuning for speed.

A nice side effect of benchmarking is that you'll also get to see how stable your system is under a heavy processing load. Many benchmarks saturate chips and buses with data, which means that the slowest part of the circuit will be operating at full tilt throughout the test. If your power supply is marginal or your voltage regulator doesn't smooth out the power very well, you'll know it after a benchmark run or two. Likewise, you'll probably also learn whether your cooling equipment can cope with a sustained load after an overclock.

Benchmark Types

Benchmarks break down into two main categories. The **synthetics** run standardized tests, such as flooding a hard drive with data or pieces of applications or games (real or fake ones) to generate a score (or several). So-called **real-world** benchmarks measure how fast an actual application or game can run on your PC or how fast a device can do a typical task, such as ripping a CD.

Some benchmark utilities are free; others may have one or more versions available at different price levels, occasionally including free trials. For personal use, you probably won't need to buy the more expensive, feature-rich versions.

Synthetic. SiSoftware Sandra Professional 2005.SR1 (\$39.99 and up;

www.sisoftware.net) is a popular suite of tests for RAM, CPU, storage, and other PC subsystems. It's updated a few times a year. Sandra is also an in-depth system setting reporting tool. Its instant comparisons to representative (albeit optimistic) benchmark scores from other devices and PCs make it especially fun for new users.

Futuremark's PCMark04 (free and up; www.futuremark.com) synthesizes typical home user duties, such as antivirus, audio-visual, encryption, and compression tasks. A PCMark score is probably the most practical way for the average user to compare two complete computers. For in-depth DirectX graphics benchmarking, there's the ever entertaining 3DMark05 (free and up).

Also from Futuremark is SPMark04 (free and up), which ascertains the speed and power consumption rate of smartphones running Symbian 6.1 or 7.0. The company also distributes some more expensive benchmarks made by the BAPCo consortium. These include MobileMark 2005 (\$499.95) for testing notebook battery life and performance, WebMark 2004 (\$299.95) for Internet transaction speeds, and SYSmark 2004 (\$399.95) for business workloads.

SPECviewperf 8.1 (free; www.spec.org) is a multiplatform video card benchmark that measures performance with the OpenGL API, as used in Doom 3. Most games use DirectX, but OpenGL is once again becoming relevant to gamers, as new titles appear using Doom 3's 3D engine.

Some benchmarks test specific hardware, such as Nero CD-DVD Speed V4.00 for CD and DVD drives (free; www.cdspeed2000.com) and HD Tach 3 for hard drives (free and up; www.simpli-software.com). Sandra includes a few drive tests, too. Because these benchmarks are synthetic, they generally tell you how fast a drive can read and/or write data under ideal conditions; that is, without demands from multiple processes or users. PCMark04 or a similar app-based suite can give you a bird's-eye view of how a new drive will affect your system's overall performance, but real-world testing will give you more concrete conclusions.

Real-world testing. Sometimes low-tech is more useful than high-tech when it

comes to testing. To really know how fast your DVD drive can write in DL mode, grab a stopwatch and burn a disc. The same goes for timing a batch process in Photoshop or encoding a video clip for your PSP. No funny scores, no synthetic this or that, just a hard result in minutes and seconds.

To this end, some games can tell you how fast your PC can render their graphics in fps (frames per second). These might gauge the fps while running a short demo or recorded piece of gameplay. If a game doesn't come with a prerecorded demo, it might have a feature that lets you record a minute or two of actual gameplay. And if there's no mechanism in the game to log average and/or peak fps, look into the Fraps utility (www.fraps.com).

Fps testing can show you the effects of a GPU/VPU or video RAM overclock, as well as a change in antialiasing, image filtering (such as anisotropic), resolution, or detail settings. The trick is to use these settings to find the best balance among image quality, eye candy, and motion fluidity in each game you play.

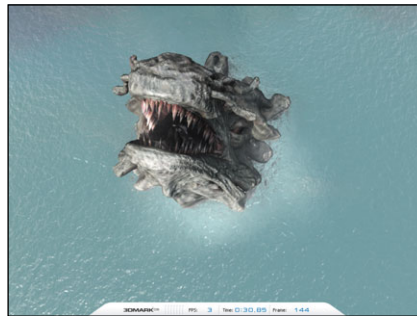
Synthetic and real-world benchmarks both have pros and cons, so run at least one of each during your testing for a more complete picture of your PC's abilities. "We have always advocated end users to use a portfolio of benchmarks," says Sales & Marketing Executive Vice President Tero Sarkkinen of Futuremark, "both applications that the end user will run on the system, as well as professionally designed benchmarking software that fits the situation in question."

On Your Mark

Before you benchmark, prep your PC to run its best. Update your OS and install the latest drivers for your motherboard, video card, and other devices. Patch your benchmark with the latest update. Next, unplug your Internet connection, and shut down extraneous apps, including antivirus, firewall, and Windows' System Restore. Disable the screen saver and power-saving features, if present. Finally, set your graphics card to the resolution, color depth, refresh rate, and feature settings that you plan to use with your apps and/or games.

If you're gunning for scores that you can compare with other users', set up your benchmark in the same way as your competitors. For instance, Futuremark offers a checklist to help testers generate externally valid results with its software (www.futuremark.com/products/3dmark05/?guidelines). For benchmarks that lack guidelines and reviewer's guides, check out the settings other testers are using in related forums or publications.

To keep driver developers from optimizing for specific benchmarks, as opposed to games or applications, Futuremark provides a list of video driver versions that have met its approval. If you're going to compare scores from a Futuremark



It's a sight like this that makes us wish Futuremark would turn some of its 3DMark05 scenarios into real games. Who wouldn't want to fight this leviathan?

benchmark, use the latest driver for your graphics card on the company's approved list at www.futuremark.com/community/drivers/?approved.

Of course, if you're only tuning your system, and you don't care how your UT2K3 fps score compares to that of someone in Singapore, keep your real-world testing in the real world. If you play games online, benchmark with your antivirus utility and firewall running, too. These apps are arguably essential when you're online, especially under Windows. You can avoid an embarrassing drop in frame rates later by factoring these security utilities into system overhead as you test.

Demos

Most benchmarking apps come with instructions or are relatively self-explanatory. Games, on the other hand, might

not document their benchmarking features, if present. Here are the procedures for benchmarking with demos in recent must-have titles.

Doom 3. Doom 3 comes with a prerecorded demo that tells you the average frame rate upon completion. Simply set Doom 3's resolution and detail settings as you see fit, then in the main menu, press CTRL-ALT-~ (the tilde key). Type **timedemo demo1** and press ENTER.

Half-Life 2. The DirectX 9 game Half-Life 2 takes a little more effort to benchmark. It doesn't come with a demo, so you'll have to record one of your own while you're playing the game. First, click Options from the main menu. Under the Keyboard tab, click Advanced, then select the Enable Developer Console (-) checkbox, and click Apply. Next, set Half-Life 2's resolution and detail settings under the Video tab and click Apply again.

Start playing until you reach a part with lots of action. Press ~ to enter the game's console mode. Type **record demo1**, substituting whatever you want to name the demo for **demo1**. Press ENTER, then ~ to return to the game. After a minute or two, end the recording mode by pressing ~ and typing **stop** and pressing ENTER. The demo should now be saved as Demo1.DEM in the game's HL2 folder, as in C:\PROGRAM FILES\VALVE\STEAM\STEAMAPPS\USERNAME\HALF-LIFE 2\HL2.

Finally, exit to the game's main menu, then press ~ again. Type **timedemo demo1** and press ENTER. After the game replays the demo file, it will report its average frame rate. An alternative is to try a third-party benchmark, such as the one at www.hardwareoc.hu/index.php/p/news/cid/7/y/6994.html.

OK, Now What?

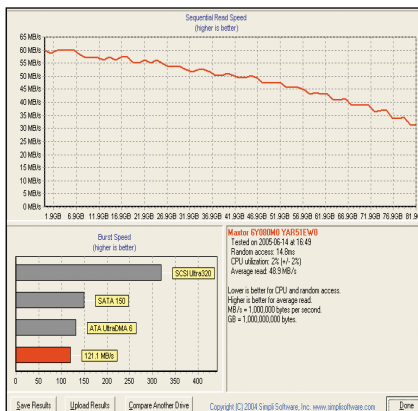
If you're only testing to see how much faster your PC is after a part swap, RAM timing adjustment, or overclock, it really doesn't matter what your scores are. What matters is how the "before" scores compare to the "afters."

On the other hand, you might enjoy the furious competition of the benchmarking community. You can compare scores on

various forums, or through integrated comparison tools, such as Futuremark's Online ResultBrowser (service.futuremark.com/servlet/Index?pageid=/orb/index). For a peek at the current top 3DMark05/03 and PCMark04 scores at press time, check out our "World Records" sidebar to the right.

One thing you *can't* do with test scores is compare one benchmark against another or even infer that a score of x in 3DMark03 necessarily correlates to a result of y in 3DMark05.

"Targeted technology level, API, or features usually differ a great deal between benchmarks," says Sarkkinen. "For example, the 3DMark product line has existed since 1998, and each product



HD Tach 3 RW is still a respectable synthetic hard drive benchmark, although it doesn't take usage patterns or multiple users into account, as did Intel's orphaned Iometer.

version has been carefully designed to measure graphics performance under a defined DirectX API with defined features supported. This means that all different 3DMark products measure different things, and that is why you cannot compare scores between different benchmark versions."

In fact, it won't even always hold true that a benchmark score will be n better when you install a 200MHz faster processor. Leaving aside new features, a faster processor might become less of a bottleneck for particular subsystems of the PC, altering their performance in the test, too. The only certain way to know how a PC would fare in a given benchmark test is to test it.

World Records

Whose rig rocks the hardest? Futuremark maintains current lists of the top 3DMark05, 3DMark03, and PCMark04 scores submitted by users around the world (www.futuremark.com/community/halloffame). Here are the best of the best at press time.

3DMark05

1. 16770 Shamino, ASUS EN7800GTX 640/1491MHz SLI, FX-55 3758MHz, "Homemade Triple Cascade" cooling
2. 16605 XtremeSystems.org 3DTeam, GeForce 7800 GTX 637/1435MHz SLI, Athlon 64 3802MHz, Swiftech MCW50 watercooling
3. 16257 2fast4u/XtremeResources.com 3DTeam, BFGTech 7800 GTX 658/1449MHz SLI, FX-57 3529MHz, watercooling
4. 16062 FROG/XtremeResources.com 3DTeam, BFGTech GeForce 7800 GTX 607/1410MHz SLI, Athlon 64 3486MHz, PC_ICE cooling
5. 15871 [EPUK] GoLLuM/extremeprometeia.com, GeForce 7800 GTX 567/1377MHz SLI, FX-57 3570MHz, r507 Mach2 phase-change cooling

3DMark03

1. 35894 XtremeSystems.org 3Dteam, GeForce 7800 GTX 275/1404MHz SLI, Athlon 64 3613MHz, Swiftech MCW50 watercooling
2. 31407 Shamino/VR-Zone Singapore, ASUS 6800 Ultra 638/1404MHz SLI, FX-55 3444MHz, "home-brewed triple Cascade" cooling
3. 30158 Sampsa & Kamu/muropaketti.com, ASUS 6800 Ultra 641/1370MHz SLI, FX-55 3173MHz, Vapochill LS cooling
4. 30000 Coolaler.com OC Team, GeForce 7800 GTX 468/1360 SLI, Athlon 64 2905MHz
5. 29995 Hard Core/VR-Zone Germany, Gainward GeForce 7800 GTX 522/1305MHz SLI, Athlon 64 2768MHz

PCMark04

1. 10089 OPB/ocXtreme.org Bench team/Anti-X.org, GeForce 6800 GT 434/1123MHz, Athlon64 X2 3405MHz, PCICE power Cascade 2 stage cooling
2. 9518 Sucka/OC PCMark Team, RADEON X850 XT 618/630MHz, Athlon 64 X2 3180MHz
3. 9364 Sampsa & Kamu/muropaketti.com, RADEON X850 XT PE 540/587MHz, Athlon64 X2 3232MHz
4. 9326 FUGGER/XtremeSystems.org 3DTeam, RADEON X850 XT PE 599/631MHz, P4 Smithfield 4997MHz, Chilly1 Cascade cooling
5. 9298 FROG/XtremeResources.com 3DTeam, GeForce 6800 GT 480/1152MHz, Athlon64 X2 3143MHz, PC_ICE cooling

Marking Onward

Some benchmark developers adapt their utilities to support new technology when it hits the shelves. But Futuremark sometimes seems to be trying to stay 18 months ahead of the available games, apps, and hardware.

Shader Model 3.0, Hyper-Threading, and multiple CPUs have already been addressed in Futuremark's benchmarks; part of 3DMark05, the Canyon Flight test, even looked forward to dual-core CPUs.

With SLI and Crossfire, 64-bit Windows XP, unified shaders, and WGF (Windows Graphics Foundation, possibly the name of the next version of DirectX) stretching out past the horizon, look for more refinements from the Finnish benchmarking behemoth.

Whatever benchmarks you choose, it will mean the end of a lot of guesswork when you're upgrading, overclocking, or tweaking. **CPU**

by Marty Sems

Dual-Core Diggity

AMD's Athlon 64 X2 4800+



AMD's high-end processor is more than just a faster version of existing technology. The Athlon 64 X2 4800+ is one of AMD's first 64-bit, dual-core processors. In late May, AMD announced four dual-core Athlon 64 X2 processors, including not only the 4800+ but also the 2.2GHz 4200+ and 4400+ and the 2.4GHz 4600+.

Dual-Core Ready To Duel With Intel

Each AMD 64 X2 processor, including the 4800+, has two processor cores incorporated onto a single die. In many ways, this gives a single AMD 64 X2 CPU the ability to deliver the same type of performance as a dual-processor system, and this power really shows when multitasking or running multithreaded apps, such as Adobe Photoshop.

Many games are still only single-threaded, however, so one processor core ends up doing the work needed to run the game while the other sits idle. It is for this reason that AMD markets its Athlon 64 X2 CPUs to digital media professionals and prosumers who want workstation-like power without the workstation price.

Although the performance of individual single-threaded applications will not improve with the Athlon 64 X2 processors, the 4800+ can still aid overall system performance, because most of us multitask,

running several programs simultaneously. We simultaneously check email, browse the Web, listen to MP3s, use instant messaging, and either play games or work. Even if you rarely run several programs simultaneously, you likely have background processes, such as antivirus scans or spyware blockers, automatically running while you use other programs. Generally, this can lead to system slowdowns, but with a dual-core processor, one CPU core can continue working on previous tasks while the second core shoulders the load from a different program.

To take advantage of the processor's dual-core design, you must have an OS that supports multiple processors or cores and multithreading. You may also need to upgrade your BIOS before both the dual-core and 64-bit capabilities are enabled on your motherboard.

Other Specs & Features

AMD updated the manufacturing process for the Athlon 64 X2 4800+. This Socket 939 processor has a Toledo core and a 90nm SOI process with 233.2 million transistors. The 4800+ also features 2MB of L2 cache, with each core contributing 1MB of L2 cache. Similarly, each core has 128KB of L1 cache, with 64KB instruction and 64KB data. As with all of AMD's Athlon 64 processors, the Athlon 64 X2 4800+ has an integrated DDR

memory controller with 128-bit controller width. The 6.4GBps memory bandwidth combines with the 8GBps HyperTransport bandwidth to provide 14.4GBps of CPU-to-system bandwidth.

All AMD 64 processors, including the Athlon 64 X2 4800+, have Enhanced Virus Protection. In order to take advantage of this technology, the processor must be installed on a system with WinXP SP2 or Windows Server 2003 SP1.

Despite the obvious performance benefits the Athlon 64 X2 4800+ can provide multitaskers, its \$1,001 price is still cost-prohibitive for most who don't use multithreaded applications. For those who do use multithreaded programs, though, the high price of one Athlon 64 X2 4800+ and a compatible motherboard is still less than that of a dual-processor motherboard and two comparable processors. **CPU**

by Kylee Dickey

AMD Athlon 64 X2 4800+	
Date Of Introduction	May 31, 2005
Clock Speed	2.4GHz
System Bus/Base Frequency	2GHz (effective)
L1 Cache	256KB (64KB instruction and 64KB data per core)
L2 Cache	2MB (1MB per core)
L3 Cache	N/A
Total Effective Cache	2MB + 256KB (2,304KB)
Supported Chipsets	NVIDIA nForce4 Ultra, NVIDIA nForce4 SLI, VIA K8T800, VIA K8T800 Pro
Supported Memory	Unbuffered PC3200/2700/2100/1600 DDR
Manufacturing Process	90nm, SOI, 233.2 million transistors
Socket Type	Socket 939
Special Features: Dual-core architecture, AMD64 technology (simultaneous 32- and 64-bit computing), and 8GBps HyperTransport rate at 2GHz, and 6.4GBps MCT rate	

Intel's Top Gun

1GHz FSB Takes The 3.73GHz P4 To New Heights



Intel 3.73GHz
P4 EE Supporting
Hyper-Threading
Technology

Intel continues to expand its range of 1,066MHz FSB processors (and the length of its product names) with the 3.73GHz Pentium 4 Extreme Edition Supporting Hyper-Threading Technology. This is only the second Intel CPU to feature an FSB higher than 800MHz, and both are LGA775 CPUs from its top-of-the-line, high-priced EE series. More significantly, though, the 3.73GHz P4 EE is among the first 64-bit, dual-core Intel chips, which were announced in February.

A Bit More Than Before

The 64-bit support is enabled through Intel's EM64T (Extended Memory 64 Technology). With EM64T, systems can support up to 8GB of memory, twice as much as the 4GB that 32-bit systems can support. In order to take advantage of the 3.73GHz P4 EE's 64-bit capabilities, you will need to upgrade your BIOS to add 64-bit support, and you will also need to install Windows XP Pro x64 or another compatible 64-bit OS (such as those of Red Hat or SuSE). Intel's EM64T processors can run in legacy mode, which lets them continue to operate with 32-bit OSes and programs.

There are only a couple of chipsets that support the high FSB of Intel's high-end 3.73GHz P4 EE: Intel's own 955X Express and 925XE Express. The Intel 915P Express and 915G Express chipsets are also compatible with the 3.73GHz P4 EE, but they support only an 800MHz FSB, so they'll keep the CPU from reaching its full potential. In addition to the speed improvement available when coupling Intel's 3.73GHz P4 EE processor with the 955X

Express or 925XE Express chipset, this pairing also lets users take advantage of the full speed available through the latest high-frequency RAM, such as 1GHz PC2-8000 DDR2. For more on PC2-8000, see "OCZ's Fastest RAM" on page 31 and "Mushkin Marches On" on page 32.

The 3.73GHz P4 EE uses an updated, 90nm manufacturing process and has 169 million transistors, whereas earlier P4 EE CPUs with HT Technology had a 0.13-micron process with 178 million transistors. With these changes in manufacturing, this newest P4 EE processor has 2MB of L2 cache. Additional cache improvements should come as the 90nm process for P4 EE processors matures.

Other Features & Specs

The 3.73GHz P4 EE Supporting Hyper-Threading Technology includes features common to some of Intel's other CPUs. As its name suggests, for instance, it includes support for Intel's HT Technology, which executes two CPU threads instead of one, resulting in a significant increase in processor and system performance. It is for this reason that processors with HT Technology are among the most popular of Intel's CPUs for high-end systems used for gaming and other performance-driven apps.

Intel's high-end P4 EE processor also includes features that are common to the majority of the company's modern processors. One such feature is Execute Disable Bit, which provides security to systems with an Execute Disable Bit-compatible OS. Supported OSes currently include Microsoft Windows XP SP2, Windows

2003 Server SP1, SuSE Linux 9.2, and Red Hat Enterprise Linux 3 Update 3. The Execute Disable Bit feature works by preventing buffer-overflow attacks by controlling the portions of memory in which code can execute. If a worm tries to insert code in the buffer, the processor can prevent the code from executing.

This processor is also built around Intel's NetBurst microarchitecture, which was first introduced with the P4 and Xeon CPUs. NetBurst provides significant benefits in the form of faster overall clock speeds with its 20-stage pipeline depth, SSE2, and faster ALU and integer-instruction execution.

With the release of the 3.73GHz P4 EE Supporting Hyper-Threading Technology, Intel demonstrated its commitment not only to the P4 EE line but also to improving the manufacturing process and overall performance of its processors that support a 1,066MHz FSB. The greatest challenge this CPU faces may well be waiting for more motherboard manufacturers to release motherboards that support its faster FSB. **CPU**

by Kylee Dickey

Intel 3.73GHz Pentium 4 Extreme Edition Supporting Hyper-Threading Technology	
Date Of Introduction	Feb. 21, 2005
Clock Speed	3.73GHz
FSB	1,066MHz
L1 Cache	N/A
L2 Cache	2MB
L3 Cache	N/A
Total Effective Cache	2MB
Supported Chipsets	(With 1,066MHz FSB support) Intel 955X Express or Intel 925XE Express; (with 800MHz FSB support) Intel 915P Express or Intel 915G Express
Supported Memory	Dual-channel DDR2-533/400
Manufacturing Process	90nm, 169 million transistors
Socket Type	LGA775
Special Features: HT Technology, Execute Disable Bit, Intel NetBurst microarchitecture, EM64T	
sSpec Number	SL7Z4

Down With Latency

Intel's 955X Express Chipset



Intel's 955X Express Chipset

In April, Intel introduced a chipset that delivers significant performance gains and works with the latest architectures, including dual-core processors, dual-channel DDR2, PCI-E, and Intel's Matrix Storage technology. Because the 955X Express chipset is compatible with four CPUs, it receives dual categorization in both entry-level workstation and high-performance multimedia classes.

The 955X Express is compatible with Intel's Pentium EE, Pentium 4 EE, Pentium 4, and Pentium D processors. When this chipset is paired with an Intel Pentium Processor Extreme Edition, Intel claims a 79% performance improvement over a 3.60GHz Intel Pentium 4 CPU with HT Technology and an Intel 925X Express chipset. This considerable improvement is due in large part to the 955X's support for the Intel Memory Pipeline Technology, DDR2 memory, and PCI Express.

As part of the 955X Express chipset, Intel Memory Pipeline Technology increases the utilization of each memory channel and accelerates the transfer rates between the CPU and system memory. In addition, all of the processors supported by the 955X Express chipset also support

Intel's Extended Memory 64 Technology, which lets workstations support larger amounts of memory and both 32- and 64-bit applications. For anyone needing lots of memory in order to edit multiple video clips or work in other applications, the 955X Express supports up to 8GB.

In order to support faster memory, increased graphics requirements, and I/O bandwidth, the 955X Express incorporates a new Memory Controller Hub backbone architecture that includes wider internal data buses supporting dual-channel DDR2 at 677MHz. Its Intel Flex Memory Technology offers easier memory upgrades by populating different memory sizes while still working in dual-channel mode.

As with its predecessors, the 955X Express chipset supports PCI-E x16 for enhanced graphics performance. The direct path between the PCI-E graphics adapters and the 955X Express chipset (instead of having to go through a bridged component) reduces latency between the adapter and the memory controller and improves performance.

The 955X Express chipset can be paired with either the ICH7 or the ICH7R southbridge, both of which support Intel High-Definition Audio for full 7.1 surround sound. When paired with the ICH7R southbridge, the 955X Express features the Intel Matrix Storage Technology with integrated RAID 0, 1, 5, or 10 abilities.

By using the abilities of the Intel Matrix Storage Technology, Intel claims that users can gain faster storage performance of up to 80% using RAID 0. While RAID 1 won't provide the same performance, it will provide the benefit of greater protection against data loss in the

event of a hardware failure. PCs equipped with RAID 5 receive the best of both worlds with fault-tolerance, faster disk access, and additional storage space.

With an ICH7 or ICH7R southbridge, the 955X Express supports connectivity for up to four SATA ports, Legacy ATA 100, or one PATA port. These chipsets also come with GbE and LAN MAC networking and support for up to eight USB 2.0 ports. In addition to RAID support with the ICH7R southbridge, you also get one PCI-E x4 port, two PCI-E x1 ports, and six PCI ports. **CPU**

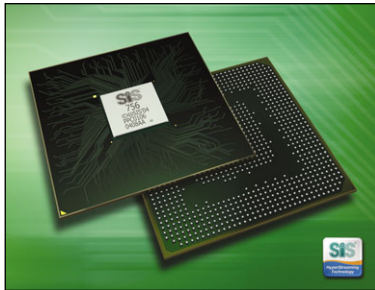
by Jennifer Johnson

Intel 955X Express Northbridge (82955X MCH)	
System Bus	1,066/800MHz
Supported Processors	Intel Pentium Extreme Edition, Intel Pentium 4 Extreme Edition, Intel Pentium 4, Intel Pentium D, and all other LGA775 Intel Pentium CPUs
Supported Memory	Dual-channel DDR2-667/533 with ECC support
Maximum Memory	8GB
Integrated Graphics	N/A
External Graphics Support	PCI-E x16
Additional Northbridge Specs	Supports dual-core processors with HT Technology, Intel Extended Memory 64 Technology, Intel Memory Pipeline Technology, DDR2, PCI-E, Intel Flex Memory Technology, Intel Active Management Technology
Southbridge (ICH7 or ICH7R)	
IDE/SATA	Four SATA ports, Legacy ATA 100, one PATA port
Storage Technology	Intel Matrix Storage Technology (with ICH7R), including integrated RAID 0, 1, 5, 10
Networking	GbE and LAN MAC
Audio	Intel High-Definition Audio for full 7.1 surround sound, AC'97/20-bit audio
Features: 1,066MHz FSB support, DDR2, PCI-E x16, up to eight USB 2.0 ports, one PCI-E x4 port (with ICH7R), two PCI-E x1 ports (with ICH7R), six PCI ports (with ICH7R)	
Released	April 18, 2005

SiS' Utility Infielders

The SiS756 & SiS965 Chipsets

The SiS756 is SiS' first northbridge chipset to combine PCI-E technologies with AMD Athlon 64 support. In addition to Athlon 64 support, this chipset also supports Athlon 64 X2 Dual-Core, Athlon 64 FX, Opteron, and



The SiS756 chipset supports many AMD processors and is compatible with PCI-E.

Sempron processors. By building in support for a variety of processor types, SiS made this chipset attractive in a variety of markets, including professional-grade servers, workstations, desktops, and notebooks. For additional flexibility the SiS756 is compatible with both 32- and 64-bit operating systems, which lets users upgrade as their needs and budgets dictate.

Notebooks utilizing the SiS756 chipset will benefit from the chipset's compliance with ACPI 1.0b and APM 1.2 standards for advanced power management, which shuts down the PCI-E interface when the devices are not in use. This results in significant savings of battery power.

Although the SiS756 doesn't have internal graphics support, it does have external support for PCI-E x16. A few comparable chipsets on the market have claimed to support PCI-E x16 and HyperTransport speeds of 1GHz on the AMD 64 platform, but in some cases tests have revealed that these chipsets only support eight of the 16 PCI Express lanes. The SiS756 has proven its ability to operate at high efficiency in graphics card driver tests. According to SiS, testing with SiSoftware Sandra 2005 shows that the SiS756 meets HyperTransport's requirements by achieving a bandwidth of

1GHz. By utilizing HyperTransport Technology, the SiS756 is able to support AMD Athlon 64 FX processors with up to 2,000 MT/s of bandwidth.

To improve overall system performance, the SiS756 chipset uses HyperStreaming technology that makes

streams of data flow smoothly within the system. SiS developed HyperStreaming technology to reduce the problems encountered when a computer tries to run multiple applications at once. This technology acts as a manager for system resources and allocates resources to the proper applications in accordance with operating requirements, bandwidth, importance, and the amount of resources available. In doing so, HyperStreaming technology lets users run multiple applications smoothly and keeps separate processes from interfering with each other. This, in turn, reduces the chance that your computer will crash.

As with other SiS chipsets, the SiS756 utilizes the proprietary MuTIOL 1G technology to connect the northbridge and southbridge chipsets. The MuTIOL 1G is SiS' 16-bit, bi-directional bus that provides a dedicated link for all peripherals and makes no bottleneck. It connects the SiS756 to one of two compatible southbridge chipsets: the SiS965 or SiS965L.

Both southbridge chips support eight channels of AC'97 7.1-channel sound and a V.90 software modem. In addition, they support dual independent IDE channels with ATA/133/100/66/33 support and up to four SATA ports with the SiS965, or up

to two SATA ports with the SiS965L. SATA ports are especially beneficial for laptop users, as they operate at a higher frequency than standard ATA ports, weigh less, and are smaller in size.

Both southbridge chipsets also feature RAID support. The SiS965 and SiS965L chipsets support RAID 0, 1, and JBOD, and SiS965 also incorporates RAID 0+1.

For networking the SiS965 supports GbE and the SiS965L supports 10/100 Ethernet. The SiS756 chipset can also combine with the SiS163 WLAN chip for 802.11b/g wireless LAN support. Both support up to two PCI-E x1 slots and up to eight USB 2.0/1.1 ports. **CPU**

by Jennifer Johnson

SiS756 Northbridge (SiS756)	
System Bus	1,000/800/600/400/200MHz
Supported Processors	AMD Athlon 64 X2 Dual-Core, Athlon 64 FX, Athlon 64, Opteron, Sempron with HyperTransport
Supported Memory	Based on CPU
Maximum Memory	Based on CPU
Integrated Graphics	N/A
External Graphics Support	PCI-E x16
Additional Northbridge Specs	Support for HyperTransport Technology, MuTIOL 1G (1GBps), HyperStreaming Technology
Southbridge (SiS965 or SiS965L)	
IDE/SATA	Dual independent IDE channels with ATA/133/100/66/33 support, up to four SATA ports (with SiS965), up to two SATA ports (with SiS965L)
Storage Technology	RAID 0, 1, 0+1, JBOD (with SiS965), RAID 0, 1, JBOD (with SiS965L)
Networking	GbE (with SiS965) or 10/100 Ethernet (with SiS965L)
Audio	AC'97 7.1-channel sound
Features: Support for PCI-E x16, up to two PCI-E x1 slots, and up to eight USB 2.0/1.1 ports (one EHCI USB 2.0 Controller and three OHCI USB 1.1 Controllers)	
Released	March 8, 2005

Mind Your Multimedia

VIA's PT894 Pro

VIA's latest chipset, the PT894 Pro, was designed specifically to meet the demands of serious power users looking for a chipset that can give them enhanced multitasking ability. It supports the gamut of Intel Pentium 4 processors with Hyper-Threading technology.

The PT894 Pro is paired with the well-aged VT8237 southbridge. Although the standard component should work just fine, most of the advanced features of the VT8237 are available as add-on controller chips. These chips let users tailor the set for their system.

Northbridge

Not only is the PT894 Pro optimized for the latest in Intel's Hyper-Threading technology, but this chipset also features a 1,066/800/533MHz FSB and VIA's own DualGFX Express technology. DualGFX Express takes advantage of the high graphics bandwidths associated with PCI Express to let users connect up to four monitors to their system. To do so users will need two graphics cards, the first setup as a primary PCI Express x16 connection and a secondary card configured as an x4 connection.

The DualGFX Express system isn't the only new technology VIA has bequeathed on its new chipset. The PT894 Pro also features VIA's StepUp Memory technology, which supports up to 4GB of DDR400/33/266 and DDR2-667/533/400 memory, giving users a

number of options while still offering fast access to system memory and top-notch performance.

Connecting the PT894 Pro northbridge to the VT8237 southbridge is VIA's Ultra V-link bus, which boasts throughput speeds of up to 1,066MBps. Its high throughput speed and low latency makes it ideal for multimedia applications.

Southbridge

VIA's VT8237 southbridge has some nice features, such as its AC'97 integrated VIA Vinyl 6-channel audio setup with support for VIA Vinyl Audio 5.1. If you want a little more audio power, you can easily add VIA's Vinyl Gold Audio on-board controller for clear audio quality through eight channel outputs.

The VT8237 has a native Serial ATA/RAID controller that can support two 150MBps SATA devices. If you use the SATALite interface, you can even add two more devices.

Also integrated in this southbridge is a V - R A I D controller that supports native RAID 0, RAID 1,

RAID 0+1, and JBOD, though the RAID 0+1 requires four SATA drives, which can only be implemented with the use of VIA's SATALite interface. Not only will this V-RAID software interface let you configure your drives easily, but it should also ensure optimum system performance.

This chip supports six PCI devices and eight USB ports and comes with

integrated 10/100 Fast Ethernet networking support, although you should add a gigabit Ethernet controller for the best network performance. It also features I/O APIC and LPC Super I/O protocols and ACPI/APM/PCI/PM power management support.

All in all this appears to be a solid chipset from VIA. The DualGFX Express technology could prove highly effective for use in multimedia studios, and if the VT8237 at first glance seems a tad vanilla, the controllers that you can add keep this chipset relevant even with the demands of the latest multimedia software. **CPU**

by Sam Evans



VIA PT894 Pro Northbridge (PT894 Pro)	
System Bus	1,066/800/533MHz
Supported Processors	Intel Pentium 4
Supported Memory	VIA StepUp Tech for dual 64-bit channel memory with co-layout support DDR2-667/533/400 DDR400/33/266
Maximum Memory	4GB
Integrated Graphics	N/A
External Graphics Support	PCI & PCI Express
Additional Northbridge Specs	Ultra V-Link (1.06 GBps)
Southbridge (VT8237)	
IDE/SATA	0 IDE/ 2 x SATA/150 devices and SATALite interface for two additional SATA devices
RAID	RAID 0, RAID 1, and RAID 0+1 & JBOD (SATA)
Networking	IVIA Velocity Gigabit Ethernet companion controller, VIA integrated 10/100 Fast Ethernet
Audio	VIA Vinyl 6-channel audio (integrated AC'97), VIA Vinyl Gold 8-channel Audio (PCI companion controller)
Features: V-MAP (VIA's-Modular Architecture Platform), VIA's Hyperion 4-in-1 unified drivers up to eight High-Speed USB ports, VIA DriveStation Controller Suite	
Released	January 31, 2005

SLI For Intel Inside

NVIDIA's First Intel-Compatible Chipset



NVIDIA's nForce4 SLI launch was clearly one of the major chipset events of the past year. In April, NVIDIA announced another, even more newsworthy version of this chipset: the nForce4 SLI Intel Edition. Even if you forget about the nForce4 SLI's many features, such as SLI graphics support and bootable RAID 5, this chipset is still a significant advance, simply because it is NVIDIA's first Intel-compatible chipset, a result of the company's November 2004 cross-licensing agreement with Intel.

A Dual-Chip NVIDIA

The nForce4 SLI Intel Edition chipset and the AMD edition share a number of features and specs, but there is one major difference between the two. The standard, AMD edition of the nForce4 SLI is a single-chip MCP, as are NVIDIA's other current AMD-compatible chipsets, but the Intel Edition is a dual-chip chipset.

This design change is out of necessity; current AMD-compatible MCPs do not require a northbridge because AMD's CPUs have an integrated memory controller.

Intel's processors do not, so Intel systems rely on the chipset's northbridge to provide memory support. In order to design a version of the nForce4 SLI that was compatible with Intel's processors, NVIDIA had to add a second chip to act as a memory controller. Instead of calling this chip the

northbridge, though, NVIDIA calls it the SPP (System Platform Processor). The SPP and MCP chips communicate through an 800MHz HyperTransport link.

This is NVIDIA's first SPP. It uses a 0.13-micron, 61-million-transistor manufacturing process. In contrast, the MCP uses a 0.15-micron, 21-million-transistor process. The SPP memory controller supports 128-bit, dual-channel, unbuffered, non-ECC DDR2-533/667 with a data-transfer rate of up to 10.6GBps. This is one significant way in which the Intel Edition varies from the standard AMD-compatible nForce4 SLI, which does not support DDR2. The Intel Edition supports up to 16GB of DDR2 through four DIMMs.

And That's Not All

The nForce4 SLI Intel Edition has several other significant features, as well. The most widely recognized of these is very likely its support for SLI technology, with which a single system can incorporate two PCI-E graphics cards using the x16 link as if it were two x8 connections. The nForce4 SLI Intel Edition chipset supports 20 PCI-E lanes and two PCI-E x16 slots. This provides configurations of either one x16 lane and four x1 lanes or, for SLI mode, two x8 lanes and three x1 lanes.

In addition, the chipset has a QDR bus of up to 266MHz, for an effective FSB of 1,066MHz, poising it to compete with Intel's own 1GHz chipsets. The chipset supports LGA775 procs, including Intel's P4 EE and dual-core Pentium D CPUs, and comes with native support for GbE, AC'97 2.3-compliant audio, and dual S/PDIF digital audio. nForce4 SLI also supports low-power suspend-to-RAM, Hyper-Threading Technology, and RAID

0, 1, 0+1, and 5 configs. NVIDIA's MediaShield storage technology tells users which drive to replace if there is a failure within a RAID array and allows for changing an array without rebooting.

The nForce4 SLI's dual storage-controller design gives it twice the bandwidth of standard single-controller designs; it can handle up to four SATA drives (with 3Gbps SATA II support) or PATA drives. It also supports up to six external PCI 2.3-compatible slots, up to 10 Hi-Speed USB ports, and UltraDMA 33/66/100/133. NVIDIA also packs in its core chipset technologies, such as QuickSync for low-latency memory access, nTune for performance monitoring and system configuration, and the hardware-based ActiveArmor Firewall.

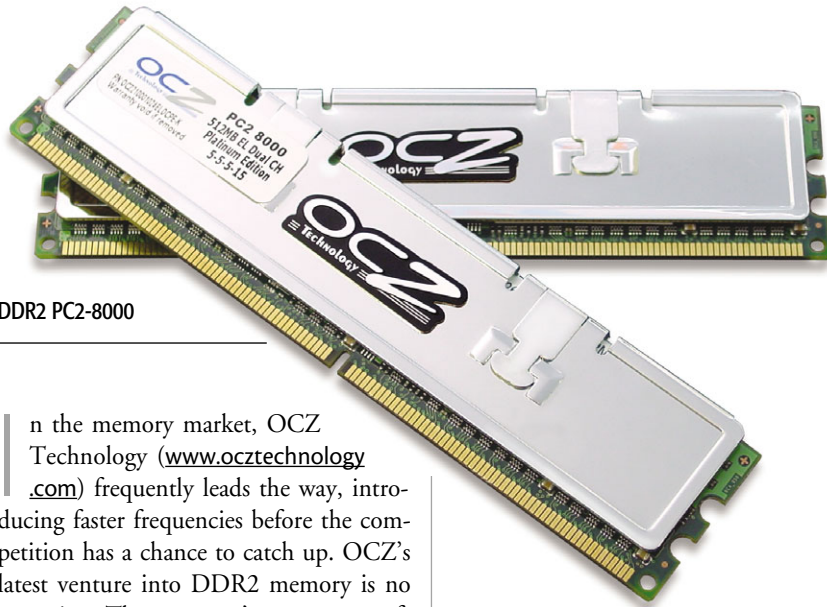
For the first time, Intel users can experience NVIDIA's MCP technology. What is perhaps most interesting about NVIDIA's first Intel-compatible chipset is that it doesn't just work with Intel's processors but actually has the features necessary to compete well against Intel's own chipsets. **CPU**

by Kylee Dickey

NVIDIA nForce4 SLI Intel Edition SPP (northbridge)	
System Bus	1,066/800MHz
Supported Processors	LGA775 P4, P4 EE (including dual-core), and Pentium D
Supported Memory	Dual-channel, unbuffered, non-ECC DDR2-533/667
Maximum Memory	16GB using four DIMMs
Integrated Graphics	N/A
External Graphics	SLI support (two x8 lanes) or standard PCI-E (one x16 lane)
Additional SPP Specs	DDR2 support, which is unique to the Intel Edition of the nForce4 SLI chipset
MCP (southbridge)	
IDE/SATA	SATA II support, up to four SATA drives, and up to four PATA drives
RAID	RAID 0, 1, 0+1, 5
Networking	GbE
Audio	AC'97 2.3-compliant audio and dual S/PDIF digital audio
Features	1,066MHz-effective FSB, SLI graphics, HyperThreading support, NVIDIA MediaShield, up to 10 Hi-Speed USB ports, and NVIDIA Firewall
Released	April 5, 2005

OCZ's Fastest RAM

OCZ's DDR2 Smashes Through The 1GHz Barrier



DDR2 PC2-8000

In the memory market, OCZ Technology (www.ocztechnology.com) frequently leads the way, introducing faster frequencies before the competition has a chance to catch up. OCZ's latest venture into DDR2 memory is no exception. The company's current top-of-the-line product is its 240-pin DDR2 PC2-8000 Enhanced Latency Platinum Edition memory.

OCZ's PC2-8000 was the first on the market with an operating frequency of a whopping 1GHz. The frequency is so groundbreaking that in order to take advantage of this memory's potential speed, you first need a motherboard that supports 1GHz. There are relatively few available, and at press time OCZ has only tested and approved the Asus P5DW2 Premium motherboard for full-speed use with its DDR2 PC2-8000 EL Platinum memory.

OCZ gives its Enhanced Latency designation to memory modules that generally have lower latencies than other memory on the market. As the only 1GHz memory available at the time of its release, however, the new PC2-8000 earned this distinction mostly by default. Its timings are not as low as those of OCZ's older, lower-frequency modules;

whereas slower frequencies typically offer CAS latencies of 3 or 4, PC2-8000 memory has relatively sluggish 5-5-5-15 timings. Although CL5 is slower than we'd like to see, such latency is not unexpected for the newest, highest-speed DDR2. Over time, latencies should come down, just as the latencies have for earlier, slower DDR2 modules.

OCZ's DDR2 PC2-8000 EL Platinum Edition memory has the familiar mirrored-copper heat spreaders that accompany all of the company's high-end memory. Currently, the PC2-8000 memory is only available in the Platinum Edition line, so all PC2-8000 modules feature platinum copper-mirrored heat spreaders, which provide cooling through greater heat dissipation. OCZ offers further protection for overclockers, as well, in the form of EVP (Extended Voltage Protection). Although the memory is rated at 2.1V, OCZ actually supports voltages of 2.2V

+/- 5%. So long as you operate PC2-8000 within this voltage range, OCZ will honor the memory's lifetime warranty; EVP is one of the best selling points for OCZ's memory modules.

Because DDR2 operates at a 2:3 ratio, even the Asus P5WD2 Premium board will only run the PC2-8000 at a native 667MHz frequency—some overclocking is still necessary to take advantage of this memory's full 1GHz potential. A 1GHz motherboard will provide sufficient headroom for such overclocking, whereas the more common 800MHz motherboards will suffer from greater stability issues when attempting to boost the PC2-8000's frequency.

OCZ hand-tests all of its memory and provides toll-free technical support. The company currently offers its PC2-8000 EL Platinum Edition DDR2 only in unbuffered, non-ECC 512MB modules (including a single 512MB Module package [OCZ210001024ELPE] and a 1GB Dual Channel Kit [OCZ210001024ELDCPE-K]), but you can expect the company to offer it in a greater range of densities and lower latencies before long.

Although OCZ's latest DDR2 modules have timings of 5-5-5-15, the company deserves credit for being first to the market with 1GHz memory. Its DDR2 PC2-8000 EL Platinum Edition memory has broken new ground, and already other manufacturers are rushing to the new 1GHz frequency. **CPU**

by Kylee Dickey

Model Name	DDR2 PC2-8000
Frequency	1GHz
Manufacturer	OCZ Technology
Registered/Unbuffered	Unbuffered
ECC/Non-ECC	Non-ECC
Package	240-pin
Latency	5-5-5-15
Voltage	2.1V
Heat spreader	Platinum mirrored copper
Warranty	Lifetime warranty with EVP (Extended Voltage Protection) of 2.2V +/- 5%
Available Densities	512MB (OCZ210001024ELPE), 1GB matched kit (2 x 512MB; OCZ210001024ELDCPE-K)

Mushkin Marches On

RAM Company Releases 667MHz
PC2-5300 DDR2



As of press time, Mushkin's top-of-the-line DDR2 memory is its PC2-5300 4-4-4-12 DDR2 Series RAM. This at a time when some manufacturers, such as Corsair and OCZ Technology, are venturing into the world of PC2-8000 DDR2, but you shouldn't overlook Mushkin RAM just because of its competitors' flashy specifications. The company's modules are consistently regarded as some of the most stable and dependable in the industry, and this stability makes it a favorite of many overclockers.

Mushkin's Fastest DDR2

Mushkin's 240-pin PC2-5300 modules are rated to operate at frequencies of up to 667MHz, without experiencing stability issues. The PC2-5300's voltage range is lower than that of the higher-frequency PC2-8000 modules. Mushkin approves its PC2-5300 4-4-4-12 DDR2

Series memory to operate within a voltage range of 1.8V to 2V.

Whereas Mushkin's DDR has had colorful PCBs that were either black or blue, the company's DDR2 modules have the more common green PCB hidden beneath their heatspreaders. The PC2-5300 DDR2 Series memory comes with preinstalled aluminum heat spreaders, which come in a variety of colors, so they look good while helping to dissipate heat. If you decide you prefer custom heat spreaders or other cooling devices, you'll find the stock spreaders easily removable.

Mushkin's available PC2-5300 DDR2 packages (complete with lifetime warranty) include a 512MB module (#991378), a 1GB module (#991381), a 1GB dual-channel kit of two matched 512MB modules (#991379), and a 2GB dual-channel kit of two matched 1GB modules (#991382). As of press time, Mushkin

only manufactures unbuffered PC2-5300 DDR2. Also, at this time, the company does not make an ECC version of its 667MHz DDR2. This is not at all uncommon for DDR2 because DDR is still the most common memory for registered and ECC systems.

How Mushkin's DDR2 Compares

As we mentioned, Mushkin's fastest DDR2 operates at a lower frequency than that of its competitors. Often when a company releases lower-frequency memory, it offers an advantage in some other spec, such as its CAS latency. Although the Mushkin memory's 4-4-4-12 timings are respectable for DDR2, other companies offer PC2-5300 and PC2-5400 memory with slightly lower latencies.

Mushkin has generally relied on its reputation for quality and stability, whereas other manufacturers try to distinguish themselves by sprinting to market with the latest, fastest frequencies. The true test of the quality of Mushkin's PC2-5300 4-4-4-12 DDR2 Series memory, then, is not in how fast it performs but in how well it performs compared to other modules of the same frequency.

We spent some time with Mushkin's PC2-5300 DDR2. To see how Mushkin's PC2-5300 4-4-4-12 DDR2 Series memory performs against other companies' high-speed DDR2 in a series of benchmarks, see "DDR2 Drag Race" on page 119. **CPU**

by Kylee Dickey

Model Name	PC2-5300 4-4-4-12 DDR2 Series
Frequency	667MHz
Manufacturer	Mushkin
Registered/ Unbuffered	Unbuffered
ECC/Non-ECC	Non-ECC
Package	240-pin
Latency	4-4-4-12
Voltage	1.8V to 2V
Heat Spreader	Aluminum (color varies)
Warranty	Lifetime warranty
Available Densities	512MB (991378), 1GB (991381), 1GB matched kit (2 x 512MB; 991379), 2GB matched kit (2 x 1GB; 991382)

Corsair Answers The Bell

RAM Maker's XMS2 Meets The PC2-8000 Challenge



Corsair XMS2
8000 DDR2

Although OCZ Technology has the distinction of being the first company to release 1GHz memory, Corsair was not far behind. In fact, both companies announced their PC2-8000 memory modules in May 2005. Corsair's XMS2 8000 DDR2 is a member of the company's standard line of 240-pin DDR2 memory. As of press time, the company's Pro Series tops out at PC2-5400 DDR2.

Corsair Cruises To 1,000MHz

At a time when many manufacturers are still producing lower-frequency DDR2, Corsair already sells 1,000MHz memory, even though only a relatively small number of motherboards support a 1GHz FSB. Corsair tests its memory on many motherboards to verify that it performs consistently at the rated frequency, timings, and voltage. However, Corsair cautions that although the memory has been verified to function at 1,000MHz, actual performance may vary depending on the overclocking margin of both your motherboard and processor. With both 1GHz memory and 1GHz motherboards so new to the market, it will be interesting to see how early adopters fare with various combinations of motherboards, processors, and memory modules.

Although OCZ Technology beat Corsair to market with its own PC2-8000, Corsair's 1GHz memory has one advantage not found in OCZ Technology's memory. Whereas OCZ's PC2-8000

achieved timings of only 5-5-5-15, Corsair's PC2-8000 has lower timings of 5-4-4-9. Both companies' 1GHz modules are tested to operate at a stable 2.2V. One thing worth noting is that, as DDR2 frequencies increase, operating voltage must also increase in order to support stable operation. Mushkin's fastest memory is currently 667MHz PC2-5300, which has both faster timings (4-4-4-12) and a lower operating voltage (1.8V to 2V). PC2-8000 users may need to enlist the help of more cooling devices than lower-frequency DDR2 users do. We've usually found that Corsair's memory is among the most stable at its rated voltage, making it an excellent choice for those who want to venture into the new world of 1GHz DDR2 memory.

Because Corsair's PC2-8000 is not yet available in its Pro Series, the memory does not come with the more stylized heat spreaders or the 24 activity LEDs found on Pro Series modules. Because Corsair's standard memory is generally the same as its Pro Series memory in other ways, it is likely that the first Pro Series PC2-8000 will feature the same CAS timings as the comparable PC2-8000 standard memory.

Corsair's 1GHz Offerings

Corsair's XMS2 8000 DDR2 is available in two packages. The CM2X512-8000UL is a single 512MB module, and the TWIN2X1024-8000UL is a 1GB dual-channel kit, which consists of two 512MB matched modules. Corsair tests each of its

matched-pair kits in an Intel-based, dual-channel-compatible motherboard before packaging and shipping the kit.

Currently, Corsair only sells unbuffered, non-ECC versions of its XMS2 8000 DDR2. All of Corsair's memory includes a lifetime warranty. As a member of Corsair's standard series of memory, the XMS2 8000 DDR2 comes with black heat spreaders that help to regulate temperatures and improve the stability and lifespan of the memory modules. Corsair's PC2-8000 memory also features OCD (Off-Chip Driver) calibration to regulate ramping voltages and ODT (On-Die Termination) to provide greater system stability.

Corsair's XMS2 8000 DDR2 was not available in time to order for this issue of PC Modder. However, you can see how other Corsair memory performed in "DDR2 Drag Race" on page 119.

Some users will undoubtedly wait until 1GHz memory matures before purchasing relatively pricey PC2-8000 memory. There is still plenty of room for latency to improve, but the deciding factor for many users will not be PC2-8000's performance but rather support for its unprecedented frequency. Corsair is among the select few to enter the 1GHz DDR2 market. With such high frequencies and faster timings than OCZ Technology's PC2-8000, the major hurdle for Corsair's XMS2 8000 DDR2 is motherboard support. As more motherboards add 1GHz FSB support, expect to see Corsair's fastest memory in more systems. **CPU**

by Kylee Dickey

Model Name	XMS2 8000 DDR2
Frequency	1GHz
Manufacturer	Corsair
Registered/Unbuffered	Unbuffered
ECC/Non-ECC	Non-ECC
Package	240-pin
Latency	5-4-4-9
Voltage	2.2V
Heat Spreader	black heat spreader
Warranty	lifetime warranty
Available Densities	512MB (CM2X512-8000UL), 1GB matched kit (2 x 512MB; TWIN2X1024-8000UL)

Enermax Takes Names (& Noise)

The Noisetaker 600W AX Is
Powerful & Feature Rich



The most powerful Enermax PSU, as of press time, is the Noisetaker EG701AX-VE-SFMA24P 600W AX. This power supply kicks out 600W of power and has a variety of features designed for the latest motherboards and video cards.

What The Noise Is About

This PSU supports the ATX 12V v.2.0 specification but, at just 3.4 x 5.9 x 5.5 inches (HxWxD), is small enough to fit in most standard-sized ATX cases. Enermax designed the 600W AX for use with today's new SLI motherboards and video cards. It has two 6-pin PCI-E connectors and two independent +12V rails, one for your motherboard and one for other components, such as video cards, drives, and fans.

The +12V rails operate at 18A (+12V1) and 17A (+12V2). Additional rails are rated at 36A (+3.3V), 45A (+5V), 0.8A (-12V), and 2.5A (+5VSB). The +3.3V and 5V rails provide up to 320W of power, while the PSU can produce up to 600W of total power.

The PSU has overvoltage, overload,

overcurrent, and overtemperature protection. Overvoltage protection is 5.5V to 7V on the +5V rail, 3.76V to 4.3V on the +3.3V rail, and 13.4V to 15.6V on each of the two +12V rails. Overload protection is 110% to 160% of the maximum load. The overcurrent protection is up to 55A for the +3.3V rail, up to 48A for the +5V rail, and up to 20A for each of the +12V rails.

The EG701AX-VE-SFMA24P is an Active PFC PSU, which provides more efficient power usage and a higher power factor than a Passive PFC PSU would. It also automatically adjusts the AC input voltage. With its Active PFC capabilities, this PSU has a PFV of 0.99 when operating at 230VAC/50Hz at full load.

The PSU has two built-in fans to minimize heat. The first is an 8cm rear fan, and the second is a 9cm fan on the bottom of the unit. BIOS settings can automatically adjust the fan speed according to thermostat readings. In addition, the 8cm fan is connected to a rheostat on the back of the PSU. By adjusting the rheostat, a user can choose a fan speed that provides an acceptable compromise between system cooling and the fan's noise level.

This PSU's fans are smart fans, which continue running for a couple of minutes after you shut down the PC. This is to continue to vent hot air out of the system. In theory, this lengthens the lifespan of components by reducing the time it takes them to cool down after system shutdown.

The Noisetaker EG701AX-VE-SFMA24P has a 24-pin main power connector and a 4-pin +12V connector. It also has a variety of cables for connecting devices. In

addition to the two 6-pin PCI-E connectors we mentioned earlier, the PSU also has seven 4-pin Molex connectors, two floppy drive connectors, a 2-pin fan-speed connector, and a 24-to-20-pin adapter.

This PSU should hold up well over time, with an MTBF of 100,000 hours at 70% of the rated load. It is compliant with UL (Level 3), cUL (Level 3), VDE, CB, NEMKO, SEMKO, DEMKO, and FIMKO safety standards. Also, devices that are attached to the same wall outlet as the Noisetaker 600W AX PSU will be protected from electromagnetic leaks thanks to Enermax Ring Core, the thick, braided wrap around the PSU's cables that provides shielding.

Powerful Performance

With support for today's most recent technologies, such as PCI-E and SLI, the Enermax Noisetaker EG701AX-VE-SFMA24P 600W AX will find a home in many newer systems. A number of other features, such as the rheostat, shielded cables, and smart fans, add to the PSU's value. Enermax includes a three-year warranty with the EG701AX-VE-SFMA24P. **CPU**

by Kylee Dickey

Enermax EG701AX-VE-SFMA24P Noisetaker AX 600W	
Rated Watts	600W
Number Of 12V Rails	2
Compatibility	ATX 12V, SLI
PFV	0.99 at 230VAC/50Hz at full load
Motherboard Connectors	24-pin, 4-pin+12V, P4
SATA Connectors?	Yes
Video Connectors	2 6-pin PCI-E
Integrated Fans	1 8cm fan, 1 9cm fan
MTBF	Over 100,000 hours at 70% of full-rated load
AC Input Operating Range	100 VAC to 240 VAC
AC Input Frequency	47Hz to 63Hz
AC Input Current	80A at 230V
DC Output (Voltage/Amps)	+5V/45A +12V1/18A +12V2/17A -12V/0.8A +3.3V/36A +5VSB/2.5A

850W Of Continuous Power

PC Power & Cooling's Top PSU



The Turbo-Cool 850 SSI is compatible with EPS12V, SSI, and SLI systems. It has 24-pin, 8-pin, and P4 connectors, as well as two 6-pin PCI-E connectors for video cards, which not only provide support for the latest video cards but also make the PSU compatible with NVIDIA's SLI technology. NVIDIA has certified this PSU for use

with SLI systems. All told, the Turbo-Cool 850 SSI has 15 drive connectors, more than most users could hope to use. Of the 15 connectors, six are SATA connectors, one is a 4-wire mini (floppy drive) connector, and eight are standard 4-wire Molex connectors.

We've seen some very flashy, brightly colored, case-mod-friendly PSUs, but the Turbo-Cool 850 SSI is not one of them. That isn't to say, though, that it wouldn't look nice in many systems. The PSU's exterior is matte black, and its cables and connectors are also black, giving it a nice, clean look that will not distract from the appearance of the rest of the case and its enclosed components.

There is one other way in which this PSU does not draw attention to itself. It performs quietly, with noise levels rated at between 32dB and 40dB. This is not an unreasonable noise level when you consider the high 850W continuous and 950W peak output of this PSU. The

PSU has one rear 30 to 52 CFM ball-bearing fan. To aid with cooling, heatsinks are built into the inside of the power supply. The extent to which the Turbo-Cool 850 SSI uses input power effectively is another way in which the PSU controls heat levels (and, therefore, noise levels). This device has a circuitry-efficiency rating of 85%, which maximizes power usage and minimizes heat.

The Turbo-Cool 850 SSI is a fairly large PSU (3.4 x 5.9 x 9.1 inches [HxWxD]), but according to PC Power & Cooling, it should fit in standard ATX cases that are at least 20 inches deep. The PSU has been approved by UL, ULC, CE, and TUV.

There is one factor that might deter many power users and modders from snapping up the PC Power & Cooling Turbo-Cool 850 SSI. Simply put, that factor is price. At \$469 not everyone can afford to equip a system with 850W of continuous power. However, those who make the considerable investment in this PSU should be encouraged both by its performance and by PC Power & Cooling's five-year warranty. **CPU**

by Kylee Dickey

PC Power & Cooling has a reputation for producing quality PSUs, but the company's latest PSU, the Turbo-Cool 850 SSI, raises the bar even further. This PSU brings a system as much as 950W of power, more wattage than any other PSU at the time of its release.

PSU Power

The Turbo-Cool 850 SSI can provide 850W of continuous power and 950W at peak output and has 85% efficiency with a 0.99 PF value. In addition to the impressive amount of power it provides, the Turbo-Cool 850 SSI also offers four independent +12V rails, each of which operates at 17A. Additional rails include +5V at 30A, -12V at 0.8A, +3.3V at 30A, and +5VSB at 2A. The four +12V rails together provide 54A (continuous) and 62A (peak). Regulation is 1% for the +3.3V, +5V, and +12V rails and 5% for the -12V rail. Overvoltage protection is provided for the +3.3V, +5V, and +12V rails. These rails also have overcurrent protection, as does the -12V rail. The PSU's MTBF is 100,000 hours.

PC Power & Cooling Turbo-Cool 850 SSI	
Rated Watts	850W (950W peak)
Number of 12V Rails	4
Compatibility	SLI, EPS12V, SSI
PFV	0.99
Motherboard Connectors	24-pin, 8-pin, P4
SATA connectors?	Yes (6)
Video Connectors	2 6-pin PCI-E
Integrated Fans	30 to 52 CFM ball-bearing
MTBF	100,000 hours
AC Input Operating Range	90 VAC to 264 VAC
AC Input Frequency	47Hz to 63Hz
AC Input Current	12A at 115V
DC Output (Voltage / Amps)	+5V / 30A
	+12V1 / 17A
	+12V2 / 17A
	+12V3 / 17A
	+12V4 / 17A
	+12V1, +12V2, +12V3, +12V4 / 54A (62A peak)
	-12V / 0.8A
	+3.3V / 30A
	+5VSB / 2A

The Mad Modder's Toolkit

Confessions Of A Languorous Mind

It's almost a running gag by now, isn't it, Dear Reader? Yes, I will continue to reprise my role as the "Mad Modder," though by so doing I feel as though I am legitimizing the stereotype of the crazy-haired loner with phat tech skillz, just trying to escape the Karaoke Nation as best he can. I don't withhold my real name out of fear it will lend my enemies great, black magic power over me—are you hearing me, Shrubber, my old nemesis?—but more to avoid an unpleasant visit from some cheerless fellows in sunglasses and suits.

Laid out before you are my thoughts on yet another group of modding parts and tools. Some rock; others blow. A few have been adjudged worthy of places in my toolkit. Whether you're

building from scratch or modding via prefab shortcuts, you'll find some interesting means to your ends here.

Lastly, this innocent column is once again inexplicably saddled with mandatory input from my esteemed editor, the legacy of some fine print in my contract. His no doubt vital contributions are faithfully recorded here, not to mention separated from my own comments by brackets. [Editor—*Hidey-ho, fellow Acer fans!*] And a thick layer of medical nitrile.

Let us mod.

by The Mad Modder

Irwin Unibit #1

I paid: \$17.99

Available at: www.amazon.com

Phreeeeowwww! Where there was no hole, a hole now exists. And I can make it bigger. I have the technology.

Ifn you need to drill as many holes as I do, whether in the course of PC modding, food preparation, or salvaging a compulsion, you probably get tired of changing bits all the time. [Ed.—*Food preparation?*] Irwin's Unibits oftentimes save the day. The further you feed the bit into the hole, the wider it cuts. Irwin also sells metric and titanium-nitride coated Unibits, plus neat carbide hole cutters.

Unibits are stepped like an Aztec pyramid, on which they used to sacrifice, sauté, and scarf their enemies [Ed.—*Gross.*], so you'll always end up with a hole

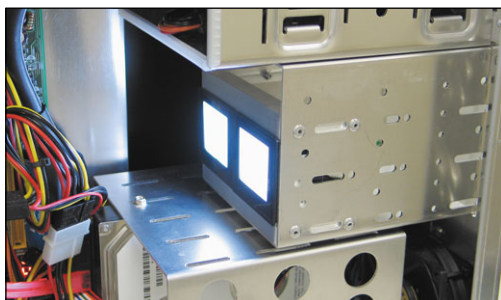
the size of a recognized metric or SAE bit. I like this one because it doesn't make me center-punch the hole first. Mind you don't booger the surface with the next step up. ▲



Lian-Li HyperCage

I paid: \$54.99

Available at: www.frozcncpu.com



Good idea, this. If you're modding a Lian-Li case, you'll like the professional-looking way this replacement floppy drive cage adds two HyperLights. These are like flood lamps for your PC. They're more white than the blue they're supposed to be, but this actually frees you up to shade them any color you like. Hit up a craft store for colored cellophane.

Lian-Li includes brushed-aluminum blanks for gussying

up the front of the cage, including one floppy fascia with a button tappet and an LED viewport. For another \$2.99 FrozenCPU will sleeve and heatshrink the Molex power leads in your choice of colors. [Ed.—*No paisley, I notice. So much for my "Purple Rain" tribute mod.*]

The only thing I don't like is that Lian-Li made the bottom two 3.5-inch bays useless by setting the HyperLights too far into them. Still, this does leave enough of a hollow to pack an Evercool ECS or a small VFD in there. Hmmm. . . ▲

Hockey Mask Horror Themed LED Steel Fan Grill

I paid: \$14.99

Available at: www.frozenscpu.com

Back when the name “Michael Myers” meant a psycho in a hockey mask, not a flatulent ogre or randy secret agent, this fan grille would’ve sent some of my friends screaming down the alley. It’s made of painted, stamped steel with blood splatters that, I’ve been assured, are not Jamie Lee Curtis’.

The blue LEDs in the mask’s eye sockets . . . hey, why are they blue? Even George Lucas knows that anyone evil has red or yellow eyes. [Ed.—Speaking of, couldn’t George have spared 15 seconds for Anakin to behead Jar-Jar in



“Episode III?”] . . . I feel funny saying this, Dear Editor, but you have a point.

Anyway, the LEDs are some of the brightest I’ve seen in a PC accessory. They are seriously a little blinding. Stare straight into them for a moment, and you’ll start to see a

hulking pair of shoulders underneath the mask and OMG is that a BUTCHER KNIFE in his hand, and Donald Pleasance is standing near me shouting, “I shot him six times!” over and over. . . . [Ed.—What does he want, a cookie? Sheez.] ▲

Flow International Dynamic Waterjet

I didn’t pay: \$90,000 and up

More information at: www.flowcorp.com

When nothing but a blow-hole in the shape of Donald Duck will complete your latest creation, you’re in waterjet territory. [Ed.—Or Anaheim. Or Orlando.] Putting it in small words, a waterjet spits water and powdered garnet at something hard enough to cut it. Really, really precisely.

You’ve probably already seen a waterjet on “American Chopper.” It’s easy to spot in that custom cycle shop because it’s not dysfunctionally trying to browbeat anyone. [Ed.—Paul Sr. gives me nightmares.] As well he should. He would floss his teeth with you.



The Dynamic Waterjet’s tilting head and new software algorithms let it perfectly adjust the cutting angle to eliminate taper in the kerf, even when rounding corners in thick metal and stone. It’s also much faster than earlier ‘jets. Pair it with an Integrated Flying Bridge and put the \$90,000 to \$250,000

on your hacked expense account. Or, better yet, someone else’s.

[Ed.—Well, garnet all.] No puns. Especially bad ones.

[Ed.—Just a little joke.] And you were one of your mother’s, I take it. ▲

Sunbeam Overclock Cooler Kit

I paid: \$14.99

Available at: www.frozenscpu.com

So, like, duh. Air outside a PC will be cooler than the air inside it. You can gain a little extra cooling power for your CPU by running a duct to it from a case fan hole.

This isn’t a new trick, obviously. I once rigged up a ram-air on a 302 Mercury using a Jeep intake duct. The trick is managing all the rain and bugs that fly in. With PCs, it’s dust and pet hair you’ve gotta watch out for. And duct kinks. And blocking airflow around other hot parts, like the RAM and northbridge.

The filters and the hole mounts would be the trickiest parts if you tried to make one of these contraptions yourself, so I’m glad they’re all here in this kit. Also, the Slinky-like, collapsible duct is stretchy enough to

work between your CPU and a hole in your side window without causing trouble when you remove the panel. It will telescope when you pull the side off the system and accordion when you put it back on. Unfortunately, my duct was barely big enough to slip over the mounts. It took me a while to work the mounts into both ends.

The kit comes with one 70mm and two 80mm fan mounts, but if you’re clever, you can fab your own to fit bigger or smaller blowers. Try the auto parts store for an air intake duct or heat stove riser tube. Just don’t choose a tube smaller than the fan diameter. If you want to duct a GPU/VPU, you’re gonna have to get creative.

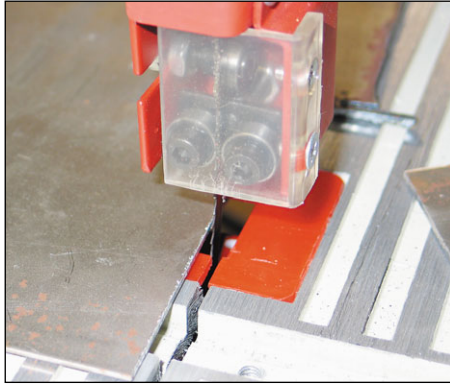
Even though Sunbeam isn’t being especially innovative here, it’s filling a niche no one else seems to be. I give the company mad props for putting everything you need in a cheap kit. ▲



Central Machinery 12-inch Bandsaw

I paid: \$124.99

Available at: www.harborfreight.com



There are good bands and bad bands. The Lovin' Spoonful? Good band.

Lonestar, responsible for the saccharine, strings-heavy ballads du jour sung by Generic Country Music Voice Guy at wedding receptions everywhere? Bad band. *[Ed.—For my money, it doesn't get any better than Josh Groban.]*

For cutting metal squarely or at a specific angle, grab a good bandsaw. This is more of an entry-level saw, but it's fine for modding and other light-fabrication duty. Keep a good grip on your work piece and slowly feed it into the hurtling blade of destruction.

This table model is friendlier to cutting sheet metal, like case panels, than the gravity style of bandsaw. I still prefer the latter for cutting tubing, rods, and so on. With a blade just 1/4-inch wide, you can cut broad curves with it if you like. It has a nice, deep 12-inch

throat, and you have about 4.6 inches of vertical clearance when you raise the upper guide rollers. The motor is a 3/4hp, single-phase unit with a separate speed control that ranges up to 2,625ft/min. Stick to slower speeds for PC case steel, a little higher for aluminum.

As I've come to expect from inexpensive power tools from China, this saw is pretty rough in spots. The table could use some polishing and a recoat of paint, whereas the miter attachment is a paragon of imprecision. Replacement blades are \$5.99 each, item 31236-1VGA.

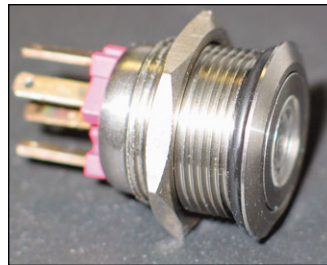
Oh, and looking more closely at the box, I notice that this thing is really intended for wood, even though the blades say they're good for steel and other metals. No wonder it could have been smoother. *[Ed.—I'm not expensing that.]* Yes, yes, you are. Or I'll tell everyone about your luncheon habits on the company credit card. *[Ed.—Kidding, kidding. He's only joking, everybody.]*

Seriously, Josh freaking Groban? *[Ed.—I celebrate the man's entire catalog. Veronicaaaa!]* ▲

Illuminated Bulgin Vandal Switch - Red Dot

I paid: \$19.95

Available at: www.performance-pcs.com



If you're trying to project heavy-duty, industrial utility with your next mod, consider this well-fashioned button that's apparently priced for the Pentagon channel. A red glow burns within the Bulgin Vandal Switch, which fits nearly flush against your case. A nitrile/silicone O-ring works against the stainless lock nut to eliminate slop and protect the case's finish.

Out back are four blade connectors. You run power switch leads to two of the connectors and power LED wires to the other two.

Experiment to figure out which. It's a momentary switch, though, which could complicate things with some motherboards if you want to use it as a power button.

My button was a little grabby throughout its stiff, short travel. There was the feel and

sound of unpolished stainless steel scraping together. It did look pretty NORAD when installed, though.

This switch is the bomb, but is it worth 20 bucks? To the right person, yeah. Check out www.bulgin.co.uk for more ideas. ▲

Drill Master Glass Drill Bits

I paid: \$7.99

Available at: www.harborfreight.com

Acrylic may be light and easy to work with, but real glass adds a certain gravitas to a mod. You know how you shake the grab bag gifts and take the heaviest one, 'cause that one must be the most expensive? The same psychology applies when you fit a custom glass panel to your project. Solidity. Foundation. Class.

But do try to use the proper type of drill bit to make the mounting holes, or you'll have a

shattered mess all over your workbench. These bits have tungsten carbide inserts in their tips, much like a masonry bit, only with a sharper angle of attack. Take your time and don't cut yourself. And for Bob's sake, wear your safety glasses.

[Ed.—Once I had a love/And it was a gas!] Methane, methinks. . . .

[Ed.—Soon turned out/ Had a heart of glass!] No singing. Or I'll see whether your jaw is glass, too. ▲



H Tools Nibbling Cutter

I paid: \$14.95

Available at: www.adpmods.com

I feel like a kendo master at times. [Ed.—*Man, I know what you mean.*] I look at a piece of sheet metal, and I say without conceit of any kind, “I could cut you in seven ways. The discipline of the bandsaw. The discipline of plasma.” Yada, yada, yada, with some philosophizin’ and a bag o’ chips.

But my power tools are in the garage. I’m in my skivvies. I’d have to put on my slippers. [Ed.—*Whoopsie. Wore mine to work today by mistake.*]

At times like these, I reach for a nibbler. With enough

leverage along a shear plane, hardened steel can easily bite through the softer stuff used to make computer case panels. Not to mention aluminum.

This Taiwanese tool isn’t heavy-duty enough for day-in, day-out use, and it’s hard to chomp out a curve with it. For right-angled holes, such as USB ports, though, it’s the bee’s knees. Just drill a hole, stick the nibbler head into it, and start munchin’.

[Ed.—*Say, did you know that half a byte is called a nibble?*] Not by anyone I associate with.

[Ed.—*I call it a nibble. And you associate with me.*] Your society is something I endure, not seek. ▲

Aspire PST-01 Power Supply Tester

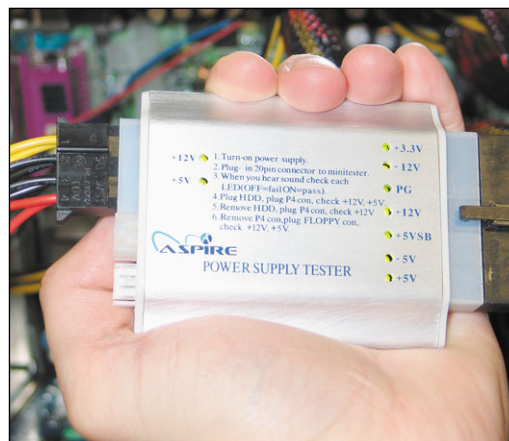
I paid: \$13.99

Available at: www.frozencpu.com

Here’s a better mousetrap than the power supply tester I covered in the last issue. That tester only had one little light. This one has nine! NINE!

Aspire’s PST-01 tests not only the 20-pin master power connector, but also the 4-pin P4 and any Molex 4-pin or floppy plugs you care to try out. No, there’s no provision for PCI-E, SATA, 24-pin, or 8-pin power harnesses just yet, so you might keep an eye out for a tester that does everything you need. Chances are, though, that any trouble in your new-fangled power supply will show up on the PST-01, and its indicators will tell you where lies the problem.

[Ed.—*What good are these again?*] Er, in case you’re just joining us, a power supply tester is an insanely time-saving diagnostic tool when



your PC clutches its chest and falls down, stone dead. It lets you interrogate the most likely murder suspect in the lineup: the power supply. [Ed.—*Good boy.*] ▲

Vantec PSU Vibration Dampener Kit

I paid: \$9

Available at: www.frozencpu.com

What a buzzkill. Speaking of power supplies, yours might not rattle when mounted in a standard case. However, a mod built from scratch can have some, shall we say, unorthodox structural characteristics. An unusual mounting arrangement could make your PSU hum like Mark Felt saying “ahh” for the dentist. [Ed.—*Eh?*] No, “ahh.”

Here’s a cheap, invisible fix. Vantec’s Vibration Dampener Kit puts a fitted, rubbery spacer between a standard power supply and a case. The spacer feels like a thin version of that mouthpiece I

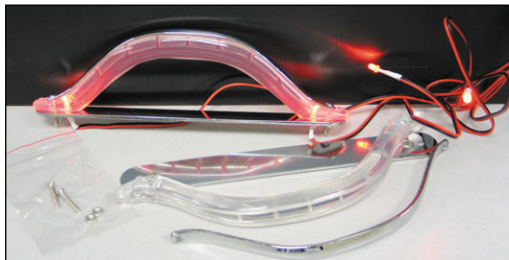
wore under my football helmet in high school. [Ed.—*I was in the band.*]

Some of my spacer’s holes were a little off in relation to my Enermax 470-watt, but hey, this thing stretches. [Ed.—*The bundle moved me from oboe to the cymbals my junior year. And later to the visitor bleachers on the other side of the field, away from everybody else.*]

... Anyway, you can look for similar dampeners for your fans, too, if you’re going for absolute silence. [Ed.—*Stupid boosters’ club. Always complaining. “You made the mascot start howling.” “You deafened a cheerleader.” Waah, waah.*] And silence seems to become more important the more editors you deal with. ▲

SunBeam LED Case Handles

I paid: \$19.99

Available at: www.frozenscpu.com

More from the firm that made “Art, Passion, and Sunbeam” the catchphrase on everyone’s lips. These are decent and sturdy and all, but do you really need case handles that light up? Actually, I’d probably use the LEDs elsewhere in a PC and just leave the handles plain.

To install these you drill four holes for each handle. Two let you mate the handle to the support plate you put inside the PC, and the other

two holes let you push the red LEDs up into abscesses in the bases of each grip. The lights feel pretty snug when you seat them into their handle holes, but Sunbeam wisely includes some C-shaped retaining clips to keep the lights in place.

Making the LEDs separate from the handles means a little more work on your part to install them, but it also makes for a clean-looking result and relatively easy disassembly. Speaking of, I’d suggest adding a lockwasher under each nut to keep the handles tight.

[Ed.—Yeah, we don’t want any nuts getting loose.] Oooh, cheap shot, mein herausgeber. ▲

Sunbeam Night Magic

I paid: \$9.99

Available at: store.yahoo.com

On the front of the package, Sunbeam calls this LED string “Bright And Neat.” On the back, it’s all “Bright And Tidy.” Please, Sunbeam! Which is it? If you can’t decide, how are we to??

[Ed.—Lighten up, Francis.]

What Sunbeam thought was simply a perfect fit for the name “Night Magic” is a string of LEDs on a flexible printed circuit, all encased in silicone. There’s no



obvious, easy way to mount it to anything, but at least you’ll get a footlong Molex Y-adapter with it. The Night Magic comes in red, blue, green, or a combo.

You can link multiple strings together, Sunbeam says—“various shapes available with user’s creativity”—and hang them in your PC or (heaven forfend) your car. [Ed.—My Neon’s gonna look so pimp!] ▲

AOSafety X-Factor XF2 Safety Glasses

I paid: \$8.99

Available at: www.harborfreight.com

X-Factor! Yeah, these safety glasses do kinda look like Cyclops’ headgear in the early issues of the “X-Factor” comic book. Except that you won’t be able to shoot red concussion beams from your eyes through them. [Ed.—Boy, my mom sure could when she was mad.]

Apparently they weren’t lethal enough. [Ed.—Zing! Didn’t see that one coming.]

Why a blue lens? Well, for style. You’ll look like freakin’ Bono when

you wear them. You can harangue politicians about African debt relief if you like. Oh, and a blue lens can make your vision sharper under fluorescent lights, which makes your time in the modding workshop more comfortable.

The XF2s give you 99.9% UV protection, too, although the package doesn’t bother to specify whether that means UV-A, UV-B, or whatever. And I don’t much like the way the arms clamp my head like a set of pincers. Ah, well, my quest continues. Plenty of styles to choose from. ▲

Dremel 400 Series XPR 3/51 Kit

I paid: \$74.99

Available at: www.amazon.com

It was high time for me to see what was new in Dremelland. [Ed.—He was acquitted. Duh.]

I said Dremelland, not . . . oh, never mind. [Ed.—But does he still have that chimp named Bubbles? Have you heard?]

No, you escaped and got a job editing. [Ed.—Zing again! You’re on fire. Sadly, only in the figurative sense...]

So anyway, Dremel’s semi-recent 400 XPR is all ergonomically blah-blah and yada-yada. The rubber inlays give you a

better grip, although the skinnier Dremels of yesteryear fit my hands better. This one feels a little fat. I do like the fact that the power switch is now separate from the rpm wheel, though.

There’s a lot of value to this kit at the \$75 price I found. The flex shaft alone is enough to get me stoked. Plus, I like the kicky, tackle-box layout of the molded case with the bits on top. Some folks have had trouble with their 400s, if the online reviews are worth believing, but mine seems to work OK thus far. ▲

Sunbeam 20 in 1 Superior Panel

I paid: \$34.99

Available at: www.frozenscpu.com



What do you want from a drive bay panel? Fan control, sure, and a temperature readout. Maybe a few USB 2.0, FireWire, and audio ports. Good enough, right? Of course not.

Sunbeam wants to give you everything but the kitchen sink. Sunbeam's little elves must have chirped a lot of "why nots" in that funny chipmunk voice they have when they threw this thing together. *[Ed.—Man, now you made me wanna go buy some helium balloons after work. There goes the evening.]*

Besides the above, some other useful stuff on the Superior Panel includes reader

slots for six of the most popular memory cards, including the Microdrive, plus headphone and audio input jacks. Even the composite video out could be handy for double-checking a movie on a TV before you burn it to DVD.

The head-scratchers are the SATA ports. Not E-SATA, but SATA. With no corresponding power jacks that could actually run a hard drive outside the case.

Unbelievably, it only costs \$35 to get all this. I've paid that much for regular fan controllers without all these bells and whistles, though they had four temp/fan channels instead of the Sunbeam's two. Even the cost of the bundled cables would be more than that. ▲

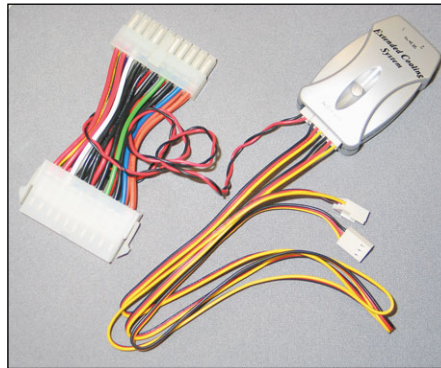
Evercool Extended Cooling System

I paid: \$16.95

Available at: www.adpmods.com

Say you're walking away from your car on a hot day. You've shut the motor off, but you can still hear the electric cooling fan whirring away. *[Ed.—That's why I call my Dodge Neon "Christine." It's like it's possessed!]*

This tidy module does the same thing for your PC: It keeps one or two fans running for about five minutes after you shut off the system (about seven minutes in my tests). It works with fans that draw their power from mobo headers, such as most CPU and small case fans.



Playing devil's advocate, I would argue that your chips continue to passively cool through their sinks anyway as soon as you shut them off. And with no electricity running through them, it's not like they're gonna get any hotter. I've no idea

whether a gizmo like this will extend your processor's life. All it might mean is that your CPU may be cooler for the first few minutes of operation should you turn your PC on again soon after you turn it off. *[Ed.—Whoop-de-ding, then.]* ▲

Sunbeam Anodized LED Fan Screws

I paid: \$7.99

Available at: www.frozenscpu.com/scr-93.html

[Ed.—Jesus wants me for a sun . . . BEAM!!/To shine for him each day . . .]

I said no singing. I mean it.

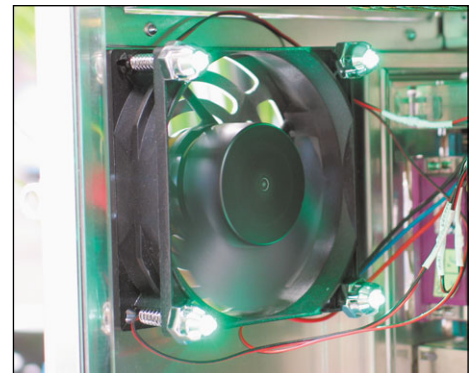
[Ed.—In every way try to please . . . HIM!!/At home, at school, at playyyyy.]

Editor, I swear I'm going to hurt you.

Now then. These are screws. For your fans. Only they have little lights in them. Their electrical connectors are separate for each power wire, so you can pass each of them through the hole before inserting the screw. Afterward, you reconnect the wires to the long Molex power adapter.

These screws, four to a set, are chromed and sturdy. Their 11-mm heads protect the LEDs pretty well. Sunbeam—

[Ed.—A SUNNN-beam! A SUNNN-beam!!/Jesus wants me for a . . .]



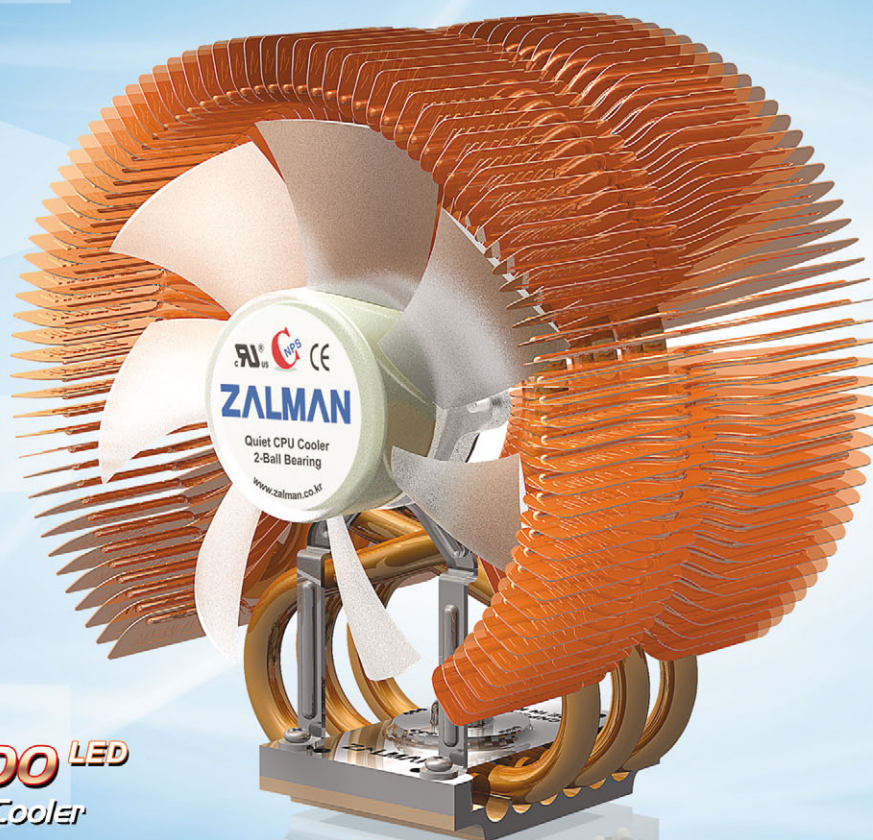
That's it. I'm coming over there. Gonna get Dremel on yo' punk—

(Connection terminated.) ▲

Endless Innovations

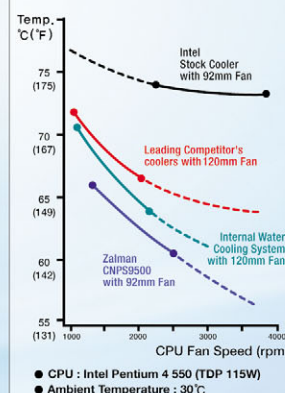
ZALMAN

The Art of Cooling Redefined

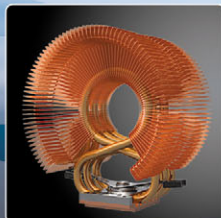


CNPS9500 LED Ultra Quiet CPU Cooler

Performance Comparison Chart



● Ultimate Performance



100% copper heatsink with aerodynamically optimized "tunnel" design for maximum cooling efficiency



Innovative patented heatpipe bending design for a heat transfer capability equal to 6 heatpipes with just 3 heatpipes

● Ultra Quiet Operation



Ultra Quiet CNPS 92mm opaque fan with blue LEDs



Aerodynamically optimized heat sink for smooth airflow and minimal noise

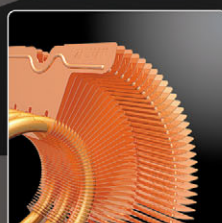
Specifications

Dimensions (L X W X H)	85 X 112 X 125 mm (3.35 X 4.41 X 4.92 inch)
Heatsink Material	Pure Copper Base Pure Copper Fins Pure Copper Heatpipes
Weight	498g (17.56oz)
Dissipation Area	3,498 cm ² (542.19 inch ²)
Fan Size	92 X 25 mm (3.62 X 0.98 inch)
Fan Operating Voltage	5-12V
Rated Current	0.35A
Max. Power Consumption	4.2W
Bearing Type	2-Ball Bearing
Fan Speed	1,350 - 2,600rpm ±10%
Noise Level	18.0 - 27.5dB ±10%
Connector	3-Pin
Fan Speed Controller	FAN MATE 2

● Minimized Weight



Optimized heatsink layout for maximum cooling efficiency with minimal materials



0.2mm ultra slim fins for minimized weight and reduced airflow resistance

● Broad Compatibility



Intel Pentium 4 (Socket 775/478)



AMD Sempron/AMD64 (Socket 754/939/940)



COMPUTER
NOISE
PREVENTION
SYSTEM

Overclock Shop

What Doesn't Kill Your System Makes It Faster

All motherboards are not equal. You can size up a board's performance potential at stock settings by glancing at its specs or reading a hardware review, but neither reviews nor spec sheets offer a clue about how a mobo will perform when you turn up the heat. That's where we come in: Every issue, we push up our sleeves and lug a massive collection of motherboards, CPUs, test systems, and caffeinated beverages into the labs.

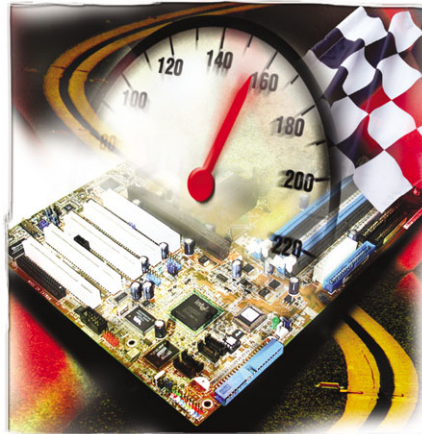
Most CPUs are compatible with multiple chipsets, so we hunt down the best combos by alternately matching each of our processors with one of three chipsets. We test each combo at stock settings and then OC them until they collapse. The result: You can pick out your favorite overclocking duo and get to work on your new benchmark-killing rig. We, on the other hand, are still waiting for the caffeine to wear off.

The Lineup

Two major chipset makers supply mainstream, AMD-based mobos: NVIDIA and VIA. They compete fiercely while SiS and ATI offer less popular chipsets. SiS hadn't released its latest chipsets when we started testing, so we're sticking with ATI's Radeon Xpress 200 and SB400. Our CPUs include the 64-bit AMD Athlon 64 series and its high-powered cousin, the Athlon 64 FX, both of which sport 939 pins.

In Intel's corner we faced mostly Intel chipsets: the 925X, 925XE, and 955X. We also snagged NVIDIA's nForce4 SLI chipset, which supports a 1,066MHz bus. We matched the chipsets with some of Intel's newest, fastest processors in the P4 and P4 Extreme Edition lines.

Mobos and CPUs aside, our test systems are nearly identical. Each rig boasts a single 128MB Chaintech 6600GT SE6600G, which plugs into the new x16 PCI Express slot. (None of our motherboards sport the old 8X AGP graphics slot.) Each test PC



also includes a 160GB, 7,200rpm Maxtor 6Y160M0 drive and a 550W Antec TruePower II PSU. All of our test systems run Windows XP Pro SP2.

Of course, we couldn't always stick to identical parts. We stocked our AMD-based test PCs with 1GB of PC3200 Corsair XMS RAM (two 512MB DIMMs), but we couldn't add them to our Intel-based systems, as those motherboards require DDR2 memory. To that end, we snagged a pair of 512MB, PC2 6400 Corsair XMS2 DIMMs. We also cooled our CPUs with different heatsinks. However, all of the heatsinks have copper bases and fins, which provide better cooling than stock heatsinks.

Testing & Overclocking

We started our testing marathon by benchmarking the systems at stock settings. Instead of using an out-of-the-box approach, we ditched the driver CDs, which generally have outdated drivers by the time they reach consumers, and instead downloaded the latest drivers from manufacturer Web sites. We also downloaded the latest BIOS versions for all our boards and flashed each BIOS before we began benchmarking. As a result the stock settings scores reflect the systems at their nonoverclocked best.

After getting these baseline scores, we turned up the heat. We entered the BIOS, punched up the clock speed a few notches, and then ran the benchmarks again. In addition to gauging system performance increases, this procedure tested each configuration's stability. If your overclocked rig crashes out of 3DMark, you've probably pushed it too far, and it won't be able to handle your games, either. We pushed our systems until they crashed and then backed down to the best, most stable settings; these are our overclocked scores.

Although many users overclock their systems to see better performance in video games, nongamers also push their systems to the limits. Overclocking affects both games and standard office tasks, so we used benchmarks that analyze both categories. Our office benchmark is Futuremark PCMark04, which provides an overall rating and individual ratings for the rig's hard drive, memory, processor, and video card.

Our video game tests include 3DMark05, Futuremark's latest 3D benchmark. The software runs several demos and then provides an overall score. Although the video card weighs heavily in the benchmark's analysis, faster CPU speeds also affect the score. Finally, we ran two real-world tests: Doom 3's built-in demo and a few minutes of Half-Life 2 gameplay we recorded to gauge the system's average fps (frames per second) performance.

The Winners & The Losers

Finally, we unloaded our data into two charts for each article. One chart shows the overclocking information, including any voltage or other settings we changed; the Overclock Comparison chart lets you assess the three motherboard/CPU combos' 3DMark05 performance at a glance. **CPU**

by Joshua Gulick

Intel Pentium 4 640 & DFI LANParty 925X-T2

Our Intel case studies are heavy on high-end Pentium 4 Extreme Edition processors, but we'll start with the nonextreme Pentium 4 640. The differences between the 500 series and 600 series aren't related at all to clock speed, which isn't much of a surprise considering Intel's been de-emphasizing clock speed recently. The biggest difference between the P4 600 series and the P4 500 series is the expanded 2MB of L2 cache found on the P4 600's core. The additional cache is a blessing and a curse. The expanded cache allows the P4 600 to hold larger blocks of data in readily accessible L2 cache. This is great for 3D applications and gaming, but it's not going to speed up Microsoft Word. In fact, for more routine applications the increased L2 cache may slow things down a bit. The problem is that if you're storing more data, it takes longer to find a specific fragment when needed. In other words, the P4 600's increased L2 cache also increases the processor's latency.

In addition to the increased L2 cache, Intel also enabled its EM64T on the 600 series, providing support for 64-bit operating systems and applications. Intel's new Enhanced SpeedStep technology allows the processor to throttle back and consume less energy when workloads are lighter.

Motherboard

In this case study, we'll be pairing the P4 640 with a DFI LANParty 925X-T2 motherboard. As the name implies, this board features Intel's 925X chipset. When first introduced, the 925X was considered

the high-end board for Intel users who wanted PCI-Express and DDR2 support. The 925XE and 955X have since replaced the 925X at the top of the Intel heap.

Like all 925X boards, the 925X-T2 is strictly a DDR2 board. The system includes four DDR2 slots to support a total of 4GB of memory. The board does support ECC, although we opted for faster, non-ECC memory for our tests.

On the southbridge, the 925X includes Intel's ICH6R. Combined with four SATA ports, the ICH6R allows you to create RAID 0, RAID 1, or JBOD disk configurations. A single IDE channel is available for legacy optical drives.

The 925X-T2 includes two Gigabit Ethernet ports. One is controlled by the Marvell 88E8053 controller, which uses the PCI-E bus to provide greater throughput when connected to high-speed networks. The Marvell 88E8001 uses the older and slower PCI bus. In addition to its high-speed Ethernet ports, the 925X-T2 also features two Firewire 400 ports.

Performance

As always, we installed the latest available drivers for our hardware before testing. Initial scores were not very impressive compared to the boards we'll examine in the next two articles. We started with an abysmal 3211 3DMark05 score that was roughly 400 points below scores posted by the ABIT and ASUS boards we'll examine next. PCMark04 scores were also disappointing, finishing south of the 5000 mark at 4870. The 4933 CPU score was just a little low compared to the other boards we

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.2GHz Pentium 4 640
Motherboard	DFI LANParty 925X-T2
BIOS	
Manufacturer	Award/Phoenix
BIOS Version	407
Chipset Driver	6.3.0.1007
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

tested the P4 640 on. The 925X-T2's 5243 Memory score did shine as the second best default Memory score in the bunch, but the 4076 Graphics score was the biggest disappointment and likely the main reason for the exceptionally low 3DMark05 score.

As in all our case studies, we ran Doom 3 in High Quality at 1,280 x 1,024 with 2X antialiasing. At these settings we managed a default frame rate of 36.1fps. We ran Half-Life 2 using the same resolution and antialiasing settings. We also changed the Filtering Mode to Anisotropic 2x and managed 41.44fps. Again, these frame rates were low compared to other boards we tested the P4 640 with.

With our initial scores recorded, we rebooted the system and pressed DEL to enter the CMOS Setup Utility. We found the overclocking-related options in the Genie BIOS Setting in the main menu. We selected CPU Operating Speed and pressed PAGE UP to change it to Manual. Using the arrow keys to scroll down to Ext. Clock (CPU/PCI) option, we typed 210 to

Processor Intel Pentium 4 640 & DFI LANParty 925X-T2

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.2GHz	200MHz	16	1.34	4870	4933	5243	4076	4421	3211	36.1fps	41.44fps
Overclocked Performance	4.19GHz	262MHz	16	1.5250	6318	6411	6911	4157	4568	3374	37.7fps	43.64fps

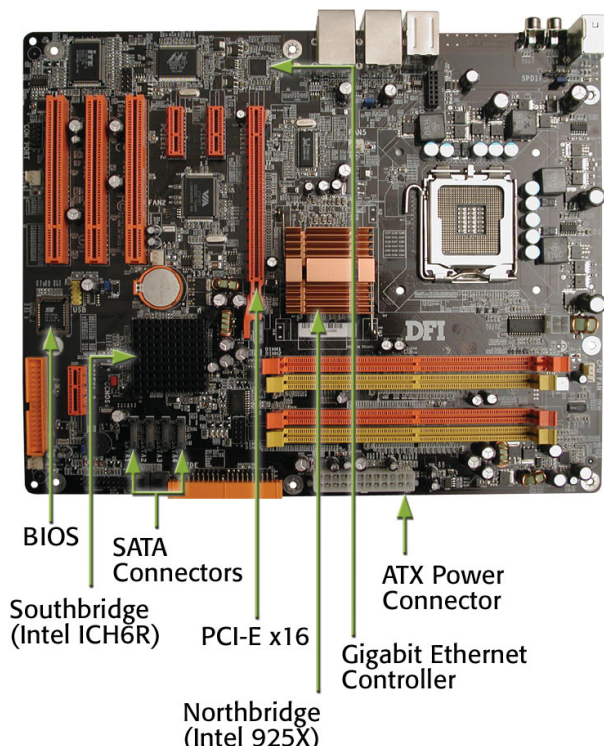
change the motherboard's FSB from 200MHz to 210MHz, resulting in a processor speed of 3.36GHz. We selected the DRAM type option and set it to DDR533 to ensure the system wouldn't underclock our PC6400 memory. We saved our settings and rebooted the system. The modest gain in clock speeds resulted in a modest 3DMark05 gain of 3222.

We increased our FSB speed once again to 220MHz, but this time we encountered some problems as the system continually rebooted right after completing its POST. We went back into the Genie BIOS Setting and selected PCI Express Frequency. We changed this setting from Auto to Fix110MHz and the system booted without any problems. Curious as to how far we could push the PCI-E frequency, we rebooted and adjusted the PCI-E frequency to 120MHz. This time the system refused to boot. At 118MHz, the system wasn't able to detect our hard drive, but at 117MHz, the system booted fine. We left the PCI-E frequency set to 117MHz and continued our testing.

At 220MHz, the processor was running at a cool (or shall we say warm) 3.52GHz. We saw a slightly more dramatic jump in our 3DMark05 score this time around, posting a 3240. At 225MHz we scored a major jump in 3DMark05 performance with a 3334 score, but the score fell to 3242 at 230MHz.

In an effort to increase our scores, we entered the Genie BIOS Settings once again and this time selected System Power Supply. We pressed PAGE UP to change the value to Manual and then selected CPU Voltage Regulator and changed the value to 1.4000V (which is the maximum specified voltage for the processor). This helped increase scores a bit, but at 3315, we were still below the 3334 score we posted at 225MHz. Increasing the CPU Voltage to 1.4250V got us back on track with a 3337.

We were easily able to get the FSB running at 250MHz (considering that Intel



uses a quad-pumped FSB, that's the equivalent of a 1GHz FSB) and the processor running at 4GHz by just increasing the FSB frequency and CPU voltage. With the FSB at 250MHz, we were pumping about 1.5000V into the processor. We encountered some problems at 260MHz. Initially, the system went black after completing its POST. Increasing the PCI-E frequency to 120MHz solved the initial problem but prevented the system from detecting our hard drive. We reset the PCI-E frequency

to 119MHz and the system booted fine, posting a 3371 3DMark05 score.

Increasing the FSB to 270MHz once again caused the system to go black after POST. We attempted to increase the PCI-E frequency again, but again at 120MHz the system could not detect our hard drive. We were forced down to 262MHz, which gave us a 4.19GHz processor clock speed (almost 1GHz faster than the P4 640's default 3.2GHz clock speed). At this speed our system memory was also clicking along at roughly 700MHz. In order to get the system stable, we did have to increase the CPU voltage to 1.5250V. We also increased the DRAM Voltage to 2.0000V and the NB 1.5V Voltage to 1.8000V.

With our quad-pumped FSB clicking along at 1048MHz, processor running at 4.19GHz, and memory running at 700MHz, our system posted some dramatic improvements. Our 3DMark05 score increased to 3374, and our PCMark04 overall score shot up to 6318, thanks to a 6411 CPU score, a 6911 Memory score, and a 4157 Graphics score. The increased clock speed, however, had little effect on frame rates. Doom 3 increased from 36.1fps to 37.7fps, and Half-Life 2 from 41.44fps to 43.64fps.

Final Word

Initial motherboards based on Intel 915 and 925 chipsets were difficult to overclock (thanks to some special measures implemented by Intel). Motherboard manufacturers have come a long way in overcoming some of the limitations imposed by Intel, and we were impressed at just how far we could push the P4 640 on DFI's 925X-based motherboard. The scores, however, were disappointing. Many of the default scores posted by our next two boards bested DFI's overclocked scores. Luckily, as you'll see, the P4 640 demonstrated similar headroom on the next two boards. **cpu**

by Chad Denton

Overclock Comparison 3DMark03

DFI LANParty 925X-T2

Stock Performance	3211
Overclocked Performance	3374

★ ABIT AA8XE

Stock Performance	3603
Overclocked Performance	3738

ASUS P5DW2 Premium

Stock Performance	3653
Overclocked Performance	3900

Intel Pentium 4 640 & ABIT AA8XE

Judging from our last article, the Pentium 4 640 appears to have plenty of overclocking headroom. In fact, it's one of the best overclocking processors we've looked at in our Modder series. We fell just short of overclocking the P4 640 by 1GHz. Perhaps we can beat the 1GHz overclock mark when we pair the P4 640 with ABIT's 925XE-based AA8XE.

Motherboard

The 925XE is the successor to Intel's 925X, but there's not a lot of difference between the two chipsets. The primary difference is that the 925XE supports the 1,066MHz FSB required by some of the high-end Pentium 4 Extreme Edition processors. The faster FSB won't have an impact in this test, however, as our P4 640 relies on an 800MHz FSB. As we start testing our 3.46GHz and 3.73GHz Pentium 4 Extreme Edition processors, however, that faster FSB will come into play.

Aside from supporting a faster FSB speed, there's not a lot new about the 925XE. Like the 925X, the 925XE chipset supports up to 4GB of DDR2 memory

allows you to create RAID arrays from SATA hard drives. The ICH6R only supports a single IDE channel for older optical drives or hard drives.

The AA8XE that we tested is a more generic version. ABIT also makes a Third-Eye and Fatal1ty version that includes added features. Unlike some of the other boards we'll examine, the AA8XE doesn't include additional IDE or SATA controllers. ABIT did include a Realtek 8110S Gigabit Ethernet controller. The 8110S utilizes the older and slower PCI bus, which may limit actual throughput a bit. A Realtek ALC880 audio codec provides 7.1-channel surround sound for high-quality audio output. You'll find an optical SPDIF output and SPDIF input on the back panel along with four USB ports and one FireWire 400 port.

Performance

It's hard to tell how far you've come, unless you have some idea of where you started. With that in mind, we ran our standard battery of benchmarks before we started overclocking.

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.2GHz Pentium 4 640
Motherboard	ABIT AA8XE
BIOS	
Manufacturer	Award/Phoenix
BIOS Version	22
Chipset Driver	6.3.0.1007
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

DFI posted, although the DFI board's CPU score was slightly lower (4933) and its Memory score was slightly higher (5243). The big difference between the two boards was the graphics performance, where the DFI board only managed a 4076 score.

Doom 3 and Half-Life 2 frame rates were also better on the ABIT board than the DFI board. We managed 39.3fps in Doom 3 and 49.95fps in Half-Life 2. Half-Life 2 frame rates in particular showed an impressive increase of roughly 8.5fps over the default DFI frame rates.

Intel Pentium 4 640 & ABIT AA8XE

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.2GHz	200MHz	16	1.3125	5154	5029	5050	4419	4584	3603	39.3fps	49.95fps
Overclocked Performance	268MHz	4.28GHz	16	1.5125	6637	6526	6732	4572	4554	3738	40.1fps	51.44fps

and, of course, it supports PCI Express. In addition to the PCI-E X16 slot for a video card, the AA8XE also includes three PCI-E X1 slots for additional expansion cards and two PCI slots for legacy cards.

To complement the 925XE on the northbridge, ABIT included an ICH6R on the southbridge. Like the ICH6, the ICH6R includes support for four SATA drives, but unlike the ICH6, the ICH6R

We started off with an impressive 3603 3DMark05 score, which was significantly better than the 3211 posted by the DFI board in our last article. ABIT also posted better PCMark04 scores. Our overall score was 5154 and components scores included a 5029 CPU score, 5050 Memory score, 4419 Graphics score, and 4584 HDD score. The overall PCMark04 score was much higher than the 4870 the

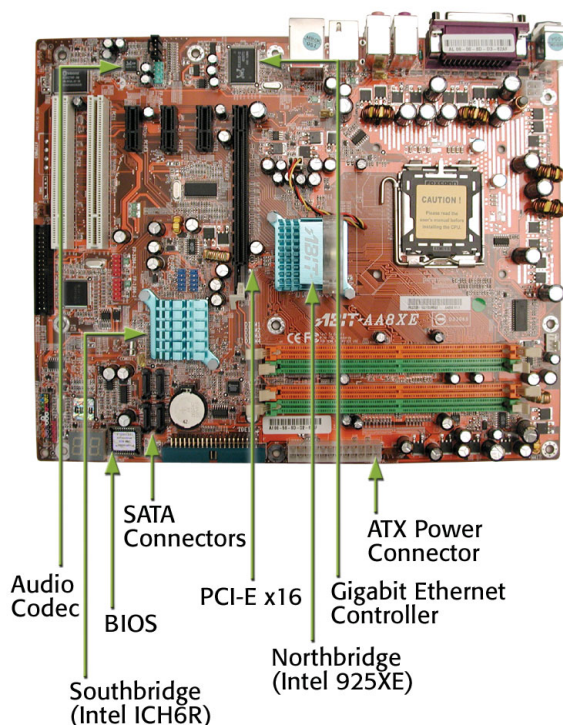
After recording our default scores, we rebooted the system and pressed DEL to enter the system's CMOS setup utility. ABIT generally keeps overclocking options in the uGuru Utility portion of the CMOS. We used the arrow keys to select CPU Operating Speed and pressed PAGE UP to change the value to User Define. We then selected External Clock and increased it from 204MHz (the ABIT

boards are sometimes slightly overclocked by default), to 210MHz. We continued to scroll down to DRAM Frequency (CPU:DRAM) and selected DDR 533 using the PAGE UP button.

We left all other settings at their default values and pressed F10 to save our changes and exit the setup utility. With the processor running at 3.37GHz, we managed to post a 3618 3DMark05 score. We continued increasing our FSB speed at intervals of 10MHz. At 250MHz, we managed to post a 3716 3DMark05 score with our processor running at 4.01GHz. At 260MHz, we ran into a bit of trouble with the system rebooting during 3D-Mark05. To get everything stable, we had to return to the uGuru Utility section in the CMOS and select PCI Express Clock. We increased this setting to 115MHz. Next, we selected PCI Clock and increased it from 33.33MHz to 36.36MHz. We also selected Voltages Control and pressed PAGE UP to change it to User Define. We increased CPU Core Voltage to 1.4625V, the DDRII SDRAM Voltage to 1.90V, and the NB Voltage to 1.60V. This gave us a disappointing 3705 3DMark05 score, so instead of increasing the FSB, we increased the CPU Core Voltage to 1.5125V. This helped performance and increased our 3DMark05 score to a more respectable 3727.

After getting the system stable at 260MHz, it was no problem stabilizing the system at 270MHz. We managed to post a 3734 score in 3DMark05 with the processor running at 4.33GHz. We were impressed by how far we were able to overclock the P4 640 on the DFI board, but the AA8XE made things even easier, and now the system appeared stable at a faster speed than we were able to reach on the DFI board.

The system booted with the FSB set to 280MHz (4.48GHz processor clock speed) but, unfortunately, 3DMark05



hung during CPU tests. We increased the processor's voltage to the maximum allowed by the board (1.6625V) but it did nothing to solve our stability issues. By increasing the Memory voltage to 2.25MHz, the NB Voltage to 1.85MHz, and setting the PCI Clock to 40MHz, we were able to complete 3DMark05, but scores at that speed were woeful. Our 3DMark05 score fell to 3625 and our overall PCMark04 score fell to 4241, well below our initial 5154. We received

Overclock Comparison 3DMark03

DFI LANParty 925X-T2

Stock Performance	3211
Overclocked Performance	3374

★ ABIT AA8XE

Stock Performance	3603
Overclocked Performance	3738

ASUS P5DW2 Premium

Stock Performance	3653
Overclocked Performance	3900

a decent 3738 3DMark05 score with the FSB set to 274MHz (4.40GHz processor clock). To get the system stable at this speed, we set our PCI Clock back to 36.36MHz, decreased our CPU Core Voltage to 1.5625V, reduced our Memory Voltage to 1.90V, and reduced our NB Voltage to 1.60V. Unfortunately, we were unable to get a PCMark04 CPU score. We had to reduce our FSB down to 268MHz in order to obtain a complete set of results for each of our benchmarks.

At 268MHz, we still had the processor running at an impressive 4.28GHz, meaning we had increased the clock speed by more than 1GHz with nothing more than a huge copper heatsink and a decent fan. In addition to our strong 3738 3DMark05 score, we also managed a solid 6637 overall PCMark04 score. Our CPU score and Memory score both saw impressive increases to 6526 and 6732, respectively. The Graphics score saw a less impressive increase to 4572 and our HDD score came in at 4554.

Doom 3 and Half-Life 2 frame rates showed little improvement. Doom 3 managed 40.1fps and Half-Life 2 managed 51.44fps.

Final Word

There's nothing like turning a 3.2GHz P4 into a 4.28GHz P4 with just a few simple tweaks to the motherboard BIOS. As our FSB speed rose from the default 200MHz to the 268MHz (1,072MHz effective FSB speed) we saw our 3DMark05 score increase from a strong 3603 to a compelling 3738. Our 3DMark05 increase, however, was nothing compared to the 1483 point increase we observed in testing with PCMark04. Next up, we'll test out the same processor with Intel's new 955X chipset. **CPU**

by Chad Denton

Intel Pentium 4 640 & ASUS P5WD2 Premium

We have been more than impressed with the Pentium 4 640's overclocking capacity. In our initial test with the DFI LANParty 925X-T2, we pumped up our 3.2GHz P4 to 4.19GHz. Our benchmarks scores, however, were less impressive. The ABIT AA8XE we tested next posted much better scores and allowed us to push our P4 640 even further to 4.28GHz. As it turns out, however, neither board was able to offer the overclocking prowess we found in the ASUS P5WD2 Premium.

Motherboard

The P5WD2 Premium includes one of the more compelling feature sets of any motherboard we've looked at. In addition to utilizing Intel's latest northbridge and southbridge chipsets, the P4WD2 includes a couple of other surprises such as an external SATA port and a PCI-E Universal slot.

In April Intel released its new dual-core processors. Because the existing 915/925 chipsets don't (officially) support dual-core processors, Intel also needed to role out a new chipset. The new 955X is similar to the older 925XE with a couple of

P4 640 won't give us an opportunity to test some of the more exciting features of this board (its faster FSB and dual core support, for instance), but we'll get a chance to examine the new features later on.

In addition to the new northbridge, the P5WD2 also includes a new southbridge. In addition to supporting RAID 0 and 1, the new ICH7R also adds support for RAID 5 and 10. The new southbridge also supports SATA II, which offers twice the bandwidth of SATA I. Unfortunately, our hard drive only supports SATA I to ensure compatibility with all the motherboards in this roundup. As a result, we won't be able to take advantage of SATA II's increased bandwidth.

As with the ICH6, the ICH7R supports just a single UltraDMA 100/66/33 IDE channel that can accommodate up to two IDE drives. Two additional IDE channels are provided by the onboard ITE IDE controller. Unfortunately, these channels only support IDE hard drives (two on each channel for a total of four), so you'll need to connect any IDE optical drives to the IDE connector controlled by the ICH7R.

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.2GHz Pentium 4 640
Motherboard	ASUS P5WD2
BIOS	
Manufacturer	American Megatrends
BIOS Version	1010
Chipset Driver	7.0.0.1019
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

socket and the back I/O panel. The second port is actually part of the back I/O panel and supports an external SATA hard drive. Like the ICH7R, the Sil3132 includes support for SATA II.

A Realtek ALC882D provides eight channels of high-definition audio, supports jack-sensing technology, and one optical and one coaxial SPDIF output. A TI 1394 controller provides two FireWire 400 ports, one on the back I/O panel and the other via an included bracket that connects to an internal connector. Intel's PCI-E Gigabit LAN controller provides

Intel Pentium 4 640 & ASUS P5WD2 Premium

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.2GHz	200MHz	16	1.3125	5086	4948	5348	4412	4573	3653	40.7fps	50.24fps
Overclocked Performance	270MHz	4.36GHz	16	1.5125	6692	6602	6759	4996	4514	3900	42.9fps	54.84fps

extras added. In addition to support for dual-core processors, the new chipset also includes support for Intel's MPT (Memory Pipeline Technology) that helps to increase memory bandwidth. We suspect the extra memory bandwidth will be needed when the system has two cores to supply with data instead of just one.

Of course, the 955X is backward compatible with single-core chips, as well. The

In addition to the four SATA ports and a single IDE channel supported by the ICH7R, the P5WD2 Premium also includes a Silicon Image 3132 SATA controller. The Sil3132 does support RAID 0 and 1. However, because the Sil3132 only supports two SATA ports, it can only support RAID 5 and 10 in software using SATA port replicators. One Sil3132 SATA port lies between the processor

faster throughput by using the new PCI-E bus. The Marvell 88E8001 Gigabit LAN controller, on the other hand, relies on the older and slower PCI bus.

Performance

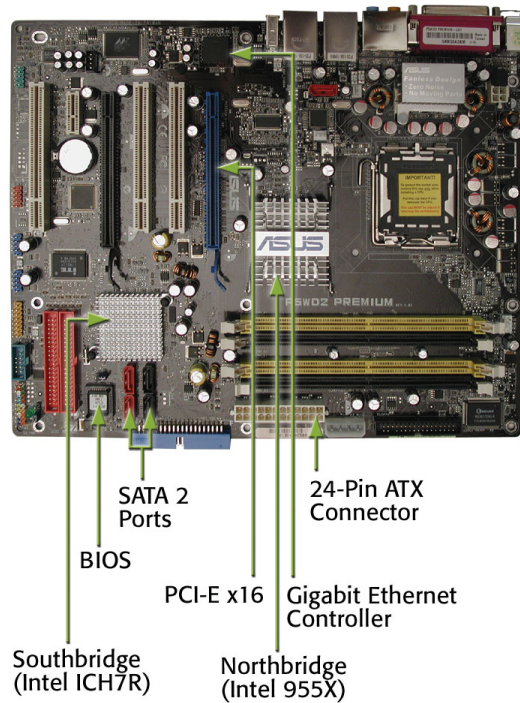
We ran our battery of benchmarks before making any motherboard adjustments. At default clock speeds PCMark04 scores were compatible with the ABIT board we looked

at, although most PCMark04 scores were slightly lower. The P5WD2 posted an overall PCMark04 score of 5086 with a 4948 CPU score, 5348 Memory score, 4412 Graphics Score, and 4573 HDD Score. With the exception of the Memory score, all PCMark04 scores were slightly lower than those of the ABIT board. The Memory score, however, was significantly higher and may have contributed to the P5WD2's 3653 3DMark05 score (the highest stock score we've received so far). The P5WD2 also did fairly well with our games posting frame rates of 40.7fps in Doom 3 and 50.24fps in Half-Life 2.

After recording the stock scores, we rebooted the system and pressed DEL to enter the CMOS Setup Utility. We pressed the right arrow key to select the Advanced tab at the top of the screen and then pressed ENTER to select the JumperFree Configuration. To manually adjust the FSB, we selected AI Overclocking, pressed ENTER, and selected Manual from the list causing a number of additional options to become available. We then selected CPU Frequency, pressed ENTER, and typed 210 to increase our FSB to 210MHz. We selected DRAM Frequency and chose DDR2-630MHz. Finally, we selected Performance Mode and pressed the + key to set the value to Standard. No further changes were required initially.

With the processor running at 3.36GHz, our 3DMark05 score rose significantly to 3817. We had no problem increasing the FSB an additional 10MHz to increase our processor speed to 3.52GHz. This time, our 3DMark05 score fell slightly to 3805, but considering the previous gain, we weren't too worried.

To overcome garbled video problems encountered with the FSB at 230MHz, we selected PCI Express Frequency in the JumperFree Configuration portion of the CMOS Setup Utility, pressed ENTER, and selected 115MHz. This fixed our



video problem and resulted in a 3827 3DMark05 score.

The increase in PCI Express frequency let us crank the FSB up to 250MHz without problems. Here our 4GHz processor posted a 3860 3DMark05 score. At 260MHz we got more garbled video. We increased the PCI Express frequency to 119MHz, but this prevented the system from detecting our hard drive. Decreasing the PCI-E frequency to 118MHz fixed our video problems while allowing the

system to detect our hard drive. Our processor posted a 3891 while running at 4.16GHz.

Increasing the FSB to 270MHz (4.36GHz) caused the system to hang while booting Windows. Under JumperFree Configuration in the CMOS, we selected CPU VCore Voltage and selected 1.5000V. Our system booted OK, but we noticed graphical artifacts. We rebooted the system and upped the CPU voltage to 1.5125V and got everything stable and running. We managed a 3900 3DMark05 score.

Attempts to go beyond 270MHz were unsuccessful. Garbled video, 3DMark05 crashes, or spontaneous reboots resulted at FSB speeds above 270MHz, despite our efforts.

Still, we managed to push the P5WD2 further than the previous two boards, and we netted ourselves some impressive results. While the P5WD2 initially trailed the ABIT AA8XE board, overclocked scores were in favor of the P5WD2. Our overall PCMark04 score was 6692 based on a 6602 CPU score, and 6759 Memory score. The 4996 Graphics score was especially impressive and far above the increase we've seen previously. Also, Doom 3 frame rates increased to 42.9fps, and Half-Life 2 frame rates increased to 54.84fps. These rates were some of the highest posted by any processor in this roundup.

Final Word

The ASUS P5WD2 Premium has an impressive feature set, but when you combine it with topflight scores and excellent overclocking capabilities, you have a formidable motherboard. The P4 640 itself gets top marks for proving to be one of the most overclockable processors we've examined. We were happy enough to get the processor stable at 4.19GHz, but we never would've thought we could produce stable scores at 4.36GHz using nothing more than air cooling. **CPU**

by Chad Denton

Overclock Comparison 3DMark03

DFI LanParty 925X-T2

Stock Performance	3211
Overclocked Performance	3374

★ ABIT AA8XE

Stock Performance	3603
Overclocked Performance	3738

ASUS P5DW2 Premium

Stock Performance	3653
Overclocked Performance	3900

Intel 3.4GHz Pentium 4 Extreme Edition & MSI 925X Neo Platinum

The Pentium 4 640 gave us a huge surprise. Not only did it post impressive numbers, but it proved extremely durable, as we managed to over-clock it by more than 1,000MHz (that sounds so much more impressive than 1GHz, doesn't it?) using nothing more than a large copper heatsink and an 80mm fan. Somehow we doubted the 3.4GHz Pentium 4 Extreme Edition will prove equally impressive.

The 3.4GHz P4 EE offers little that you can't find in the Pentium 4 600 series. The processor's chief attraction is its 2MB of L3 cache. Of course, the P4 600 series features 2MB of L2 cache. Both processors run on the same 800MHz FSB.

In some respects the P4 600 series offers more features than the 3.4GHz P4 EE. The 600 series uses the new 90nm transistors as opposed to the 0.13-micron (or 130nm) transistors the 3.4GHz P4 EE uses. The P4 600 series also includes Intel's EM64T 64-bit extensions.

instruction pipeline and 2MB of L3 cache, which should help performance.

Motherboard

We'll start off by pairing the 3.4GHz P4 EE with the MSI 925X Neo Platinum. Intel's 925X was one of the first chipsets to support DDR2 and PCI Express, but the 925X is starting to look old, as it lacks support for Intel's new 1,066MHz FSB and the company's new dual-core processors. That means you can forget about running Intel's latest Extreme Edition processors on the 925X. The 3.4GHz P4 EE, however, is an older model that still runs on an 800MHz FSB.

The 925X Neo Platinum supports 4GB of DDR2 memory, but its memory frequency is limited to 533MHz. Some of the higher-end boards we'll examine later include support for faster memory frequencies, as we start to make the jump to a 1,066MHz FSB.

On the southbridge is Intel's ICH6R, which lacks support for SATA II but still

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.4GHz Pentium 4 Extreme Edition
Motherboard	MSI 925X Neo Platinum
BIOS	
Manufacturer	Award/Phoenix
BIOS Version	v1.6
Chipset Driver	6.2.1.1001
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

sound. The motherboard includes both a coaxial and optical SPDIF output on the rear I/O channel. The Broadcom BCM5751 Gigabit Ethernet controller uses the PCI-E bus to provide greater throughput, while an Intel 10/100 Ethernet controller runs on the PCI bus. A FireWire port is also available on the rear I/O panel. Two additional motherboard headers can support another two FireWire ports. You can connect the included bracket to these headers or addi-

Intel 3.4GHz Pentium 4 Extreme Edition & MSI 925X Neo Platinum

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.4GHz	200MHz	17	1.5500	5285	5152	5072	4433	4571	3601	39.3fps	50.07fps
Overclocked Performance	3.77GHz	222MHz	17	1.5500	5774	5740	5673	4463	4582	3659	38.8fps	50.10fps

But the 3.4GHz P4 EE has a few favorable things going for it. For instance, it uses a smaller data pipeline, which should make it a little more efficient. One reason Intel increased the L2 cache in its Prescott core was to offset the performance hit from Prescott's longer data pipeline. (The longer pipeline was deemed necessary to ramp up clock speeds.) Our 3.4GHz P4 EE has a shorter

provides RAID 0 and RAID 1 support on its four SATA ports. The ICH6R also supports a single IDE channel. The VIA 6410 IDE RAID controller supports two additional IDE channels and supports RAID 0, RAID 1, and RAID 0+1 across connected hard drives. No additional SATA controller is present on this motherboard.

The C-Media CMI9880L provides high-definition 7.1-channel surround

tional FireWire ports that might be integrated into your case.

Performance

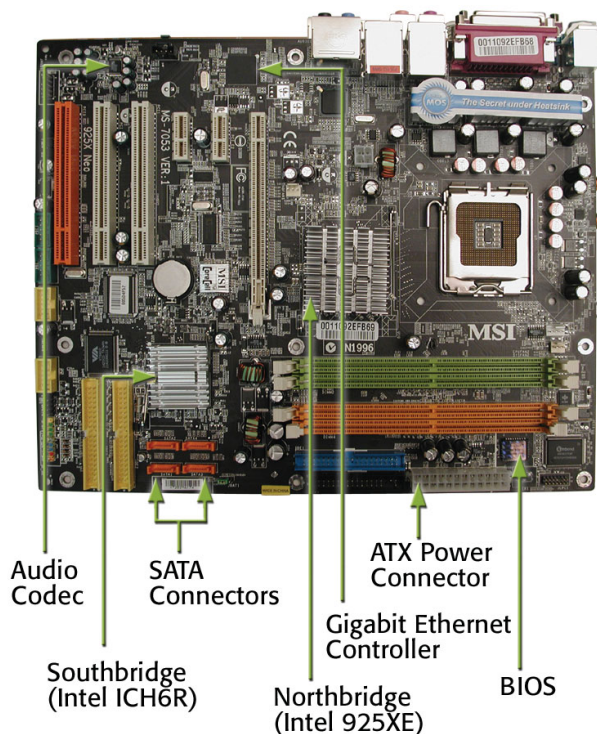
As always, we installed the latest drivers and BIOS update before beginning our tests. The initial 3601 3DMark05 score was a little disappointing considering the Pentium 4 640 posted a stock 3603 3DMark05 score on the ABIT AA8XE.

PCMark04 scores, however, made a better showing.

We posted an overall PCMark04 score of 5285, the highest stock overall PCMark04 score to date. The 5152 CPU score was equally strong, while the 5072 Memory score was a little more toward the low end. The 4433 Graphics score and 4571 HDD score were typical for our hardware. We managed 39.3fps in Doom 3 and 50.07fps in Half-Life 2. Neither frame rate was overly exciting.

After recording our initial score, it was time to see how far we could push the 3.4GHz P4 EE. We rebooted the system and pressed DELETE during the system's POST to enter the CMOS Setup Utility. The overclocking options are located in the Cell Menu section. To increase the processor's clock speed, we increased the motherboard's FSB by selecting CPU Clock in the Cell Menu section and typing **210** (raising the processor's clock speed to 3.57GHz). We also set Adjust DDR Frequency to DDR 533 to make sure the motherboard wouldn't underclock our memory as we increased the FSB. No further adjustments were required at this speed, and the system responded with a slightly increased 3DMark05 score of 3629.

Increasing the FSB to 220MHz prevented us from booting Windows. At this FSB speed, the PCI-E frequency can sometimes cause problems if left at 100MHz, so we increased it to 118MHz. The change allowed us to boot Windows and post a much improved 3656 3DMark05 score. After increasing the FSB to 230MHz, the system continually rebooted each time we tried to load Windows. Usually, increasing the processor's voltage solves any stability problems, so we returned to the Cell Menu and increased the processor's CPU Voltage. As we soon discovered, however, the system ignores its CMOS settings and locks onto a 200MHz FSB any time you increase the



processor voltage. We returned the CPU Voltage setting to By CPU Default and tried increasing the Memory Voltage and AGP/PCI Express Voltage settings to try and stabilize the system. Unfortunately, we were unable to get the system running at 230MHz, so we began reducing the FSB. We fell all the way back to 222MHz before the system was stable enough to make it through all our benchmarks.

With the FSB set to 222MHz, the processor was running at just 3.77GHz, a

mere 370MHz faster than its stock speed and a far cry from the kind of speeds we saw with the Pentium 4 640. With meager gains come meager benchmark improvements. When all was said and done, our 3DMark05 score rose to just 3659. Our overall PCMark04 score showed more of an increase to 5774. The CPU and Memory scores showed the most improvements, with the CPU score increasing nearly 600 points to 5740 and the Memory score increasing more than 600 points to 5673. Our Graphics score increased slightly to 4463, and our HDD score remained largely unchanged at 4582. Frame rates in Doom 3 actually decreased slightly to 38.8fps, but Half-Life 2 frame rates showed a very small increase to 50.1fps.

Final Word

Well, it's still early, and we have yet to see how the 3.4GHz P4 EE runs on Intel's 925XE and 955X chipsets, but so far we're unimpressed. The Pentium 4 640 (which is quickly becoming one of our most beloved processors) posted similar and, in some cases, better numbers than we received with the speedier, more expensive 3.4GHz P4 EE. Of course, scores for the P4 640 on the 925X-based DFI LAN-Party 925X-T2 were also woefully low compared to the other boards, so we have cause to hope that scores will rebound as we move on to 925XE and 955X chipsets.

One joy of overclocking is seeing how far you can push something, and in that regard, the 3.4GHz P4 EE is a disappointment. A mere 370MHz increase doesn't seem like much after seeing the P4 640's clock speed increase by more than 1GHz. Unfortunately, given the 0.13-micron core, we weren't surprised to find ourselves with a little less overclocking headroom. We can probably expect similar limitations with the other chipsets. **CPU**

by Chad Denton

Overclock Comparison 3DMark05

MSI 925X Neo Platinum

Stock Performance	3601
Overclocked Performance	3659

★ ASUS P5AD2-E Deluxe

Stock Performance	3688
Overclocked Performance	3697

Gigabyte GA-8I955X Royal

Stock Performance	3651
Overclocked Performance	3685

Intel 3.4GHz Pentium 4 Extreme Edition & ASUS P5AD2-E

We weren't overly impressed with the 3.4GHz Pentium 4 Extreme Edition in our last case study, but we're hoping for better performance as we move to Intel's newer 925XE and its 955X chipsets. Regardless of our individual scores, it's becoming clear to us that overclocking the 3.4GHz P4 EE isn't going to be nearly as easy as overclocking the Pentium 4 640 we examined earlier. A major obstacle is that the processor's 130nm transistor size provides less headroom for overclocking than the company's newer 90nm transistor size.

Motherboard

This time we'll be pairing the 3.4GHz Pentium 4 Extreme Edition with the 925XE-based ASUS P5AD2-E Deluxe. The 925XE is similar to the 925X we examined on MSI's 925X Neo Platinum in the last case study. Essentially, the 925XE is just a tricked-out 925X that includes support for Intel's 1066MHz FSB. This support allows the P5AD2-E and other 925XE boards to run the newest line of Intel

SATA II. The single IDE channel supported by the ICH6R lets you connect up two legacy IDE devices. An ITE RAID controller provides two additional IDE channels and provides RAID 0, 1, 0+1, and JBOD support across both channels.

Although most of our boards feature two integrated Ethernet ports, the P5AD2-E only includes a single Gigabit Ethernet port that's powered by a Marvell 88E8053 Ethernet controller. A C-Media CMI9880 provides 7.1-channel high-definition audio using the six speaker jacks located on the rear I/O panel. Alternatively, you can connect the P5AD2-E to an external surround sound receiver using either the coaxial or optical SPDIF outputs. Finally, a Texas Instruments FireWire 400 controller provides IEEE 1394a connectivity via the rear I/O panel. A second header on the motherboard lets you connect an additional FireWire port.

Performance

Once again, we ran each benchmark at the system's default settings (after installing the latest drivers and BIOS

System Specs

Processor, Motherboard & Drivers	
Processor	Intel 3.4GHz Pentium 4 Extreme Edition
Motherboard	ASUS P5AD2-E Deluxe
BIOS	
Manufacturer	American Megatrends
BIOS Version	302
Chipset Driver	7.0.0.1009
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800
Common Components	
Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

frequencies. The 4504 Graphics score and 4577 HDD score were also slightly better than the scores posted by the MSI board. We also managed frame rates of 39.8fps and 50.64fps in Doom 3 and Half-Life 2, respectively.

With the scores recorded, it was time to see how well the P5AD2-E overclocked our 3.4GHz P4 EE. We rebooted the system and pressed the DELETE key to enter the system's setup utility. We used the Right arrow key to select the Advanced tab at the

Intel 3.4GHz Pentium 4 Extreme Edition & ASUS P5AD2-E Deluxe

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.4GHz	200MHz	17	1.5500	5388	5236	5321	4504	4577	3688	39.8fps	50.64fps
Overclocked Performance	3.74GHz	200MHz	17	1.5500	5821	5652	5659	4523	4581	3697	40.1fps	50.86fps

Extreme Edition processors that run on the new 1,066MHz FSB. Unfortunately, our 3.4GHz P4 EE runs on the older 800MHz FSB, so we won't really get to take advantage of the faster FSB this time around.

Complementing the 925XE northbridge is an Intel ICH6R on the southbridge. The ICH6R supports RAID 0 or 1 across four SATA ports. Unlike the ICH7, the ICH6R lacks support for

update, of course). The P5AD2 put up better all-around numbers than the MSI board we looked at previously, starting with a 3688 3DMark05 score. The system managed a 5388 overall PCMark04 score, thanks primarily to strong CPU and Memory scores of 5236 and 5321, respectively. The Memory score, in particular, was much improved thanks to the P5AD2-E's support for faster memory

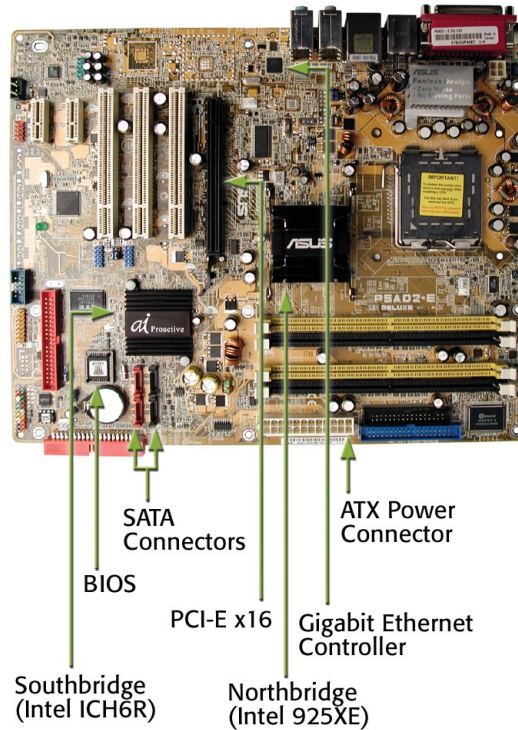
top of the screen and then pressed ENTER to select JumperFree Configuration. We selected AI Overclocking, pressed ENTER, and selected Manual. We used the Down arrow key to select CPU Frequency and changed the value from 200 to 210. The increase in FSB speed meant an increase in processor speed from 3.4GHz to 3.57GHz. We selected 560MHz for our DRAM Frequency, set the Performance Mode to

Standard, and left all other settings intact. The changes resulted in an 11-point 3DMark05 increase. Next we increased our FSB another 10MHz to 220MHz. This also increased our DRAM Frequency by 26MHz to 586MHz. At this speed our 3DMark05 score was practically unchanged at 3697.

We expected some difficulty moving to 230MHz, especially given the fact that the 3.4GHz P4 EE doesn't appear to be a great overclocker. After increasing the FSB to 230MHz, Windows hung while loading. Usually at around 220 to 230MHz we have to increase in the PCI Express Frequency, so we weren't too concerned. We simply selected PCI Express Frequency in the JumperFree Configuration section and set the value 110MHz (usually more than enough to stabilize the system). This change was enough to boot Windows, but our system rebooted in the middle of testing with 3DMark05.

We tried all the usual tricks to stabilize the system. We increased the CPU VCore Voltage, Memory Voltage, Chipset Voltage, and FSB Termination Voltage in the JumperFree Configuration section. All had different effects on the system that ranged from causing Windows to freeze while loading to causing the system to reboot in the middle of 3DMark05.

After exhausting all options in the JumperFree Configuration section, we played elsewhere in the setup utility. Under the Advanced tab, we selected Chipset Configuration and disabled Hyper Path 2. We also tried increasing power to the PCI Express slot by selecting Slot Power in the Chipset Configuration menu and trying the Heavy and Heavier options. Nothing worked. Reluctantly, we backed down to 225MHz, but once again, 3DMark05 caused the system to reboot in midtest. Increasing component voltages didn't help to stabilize the system, so we reduced the FSB to 223MHz. Again we encountered similar problems and were unable to stabilize the system. Finally, when we found



similar problems at 221MHz, we decided to move back down to 220MHz.

The increase in performance, not surprisingly, was relatively small, especially compared to the increases we saw with our Pentium 4 640. Nonetheless, we were able to increase our overall PCMark04 score 433 points to 5821. The CPU score saw the single largest increase in PCMark04 component scores increasing from 5236 to 5652. Our Memory score also increased nicely to 5659. The PCMark04 Graphics score saw a

much more modest increase to 4523 and our HDD score remained virtually unchanged at 4581. Doom 3 and Half-Life 2 frame rates checked in at 40.1fps and 50.86fps, respectively.

Final Word

Out of the three boards we tested the 3.4GHz P4 EE with, the ASUS P5AD2-E proved to be the least overclockable, although it wasn't far behind either of the other two boards we tested with this processor. Performance scores, however, were solid and generally a little better than scores provided by the MSI 925X Neo Platinum in our previous case study. In fact, our stock overall PCMark04 score was more than 100 points higher and our stock 3DMark05 score was 87

points higher. Although the MSI 925X Neo Platinum was able to push the processor a little further to 3.77GHz, the extra clock speed meant almost nothing in terms of performance. While the MSI board did post better overclocked CPU and Memory scores, the P5AD2-E's overclocked overall PCMark04 and 3DMark05 scores easily beat those posted by the MSI board.

Compared to the 3.2GHz Pentium 4 640, the 3.4GHz Pentium 4 Extreme Edition doesn't provide a whole lot of extra bang for its price. Our 3DMark05 score was 85 points higher than the score posted by the P4 640 on the ABIT AA8XE (which also uses a 925XE chipset). Our stock CPU score in PCMark04 was 207 points better. In our video game testing, the 3.4GHz P4 EE meant only about an extra 0.5fps in both Doom 3 and Half-Life 2 with each board's default settings.

Next, we'll test the 3.4GHz P4 EE with Gigabyte's 955X motherboard and see if we can't find a way to push our 3.4GHz P4 EE a little beyond the 3.8GHz limit that seems to be giving us so many problems of late. **CPU**

Overclock Comparison 3DMark05

MSI 925X Neo Platinum

Stock Performance	3601
Overclocked Performance	3659

★ ASUS P5AD2-E Deluxe

Stock Performance	3688
Overclocked Performance	3697

Gigabyte GA-8I955X Royal

Stock Performance	3651
Overclocked Performance	3685

by Chad Denton

Intel 3.4GHz Pentium 4 Extreme Edition & Gigabyte GA-8I955X Royal

So far Intel's expensive 3.4GHz Pentium 4 Extreme Edition hasn't shown us much in terms of performance, at least not enough to justify the fact that it costs more than three times as much as the Pentium 4 640 we examined earlier. When it comes to overclocking, the 3.4GHz Extreme Edition has been predictably poor. The processor uses Intel's aging 0.13-micron fabrication process, a process Intel had to move away from in order to increase clock speeds. So far, overclocking the processor has been limited to around 300MHz faster than its stock speed, a far cry from the 1,000MHz overlocks we saw on the P4 640.

Motherboard

Our last pairing for the 3.4GHz P4 EE is Gigabyte's GA-8I955X Royal motherboard. The GA-8I955X relies on Intel's 955X northbridge, which supports as much as 8GB of DDR2 memory. Like the 925XE we looked at previously, the 955X also supports 1,066MHz FSB. It also

ports. Silicon Image's 3132 SATA II controller provides two additional SATA II ports and supports RAID 0 and RAID 1. Although the ICH7R only supports a single IDE channel, the GA-8I955X does include a GigaRAID IT8212F controller that provides two additional IDE channels. The IT8212F supports RAID 0, 1, 0+1, and JBOD across as many as four hard drives on the two channels.

The ICH7R also supports up to eight USB 2.0 channels, and a Texas Instruments FireWire 800 controller supports up to three FireWire 800 ports. Two FireWire ports are integrated into an included bracket, and one additional header lets you connect any FireWire port you may have integrated into your case. An ALC882 provides 7.1 channels of high-definition audio and supports both coaxial and optical SPDIF outputs. Finally, two Broadcom Gigabit Ethernet controllers provide two networking options.

As with other Gigabyte boards, the GA-8I955X also includes Gigabyte's U-PLUS

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.4GHz Pentium 4 Extreme Edition
Motherboard	Gigabyte GA-8I955X Royal
BIOS	
Manufacturer	Phoenix/Award
BIOS Version	F5
Chipset Driver	7.0.0.1025
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

Gigabyte bundles a Bluetooth dongle with its GA-8I955X Royal motherboard. The dongle plugs into any USB 2.0 port and lets you connect to other Bluetooth-enabled devices, including cell phones, notebooks, PDAs, and even headsets.

Performance

We originally used the Windows-based flash utility to update our BIOS, but the update failed using this utility, preventing the system from booting with the new

Intel 3.4GHz Pentium 4 Extreme Edition & Gigabyte GA-8I955X Royal

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.4GHz	200MHz	17	1.5500	5350	5054	5329	4447	4574	3651	39.5fps	51.17fps
Overclocked Performance	3.74GHz	200MHz	17	1.6000	5889	5618	5865	4451	4570	3685	39.9fps	51.58fps

includes support for Intel's new dual-core Pentium D processors. Unfortunately, we won't be able to test either this time around, as our 3.4GHz P4 EE runs on the older 800MHz FSB and it certainly doesn't include more than a single core.

Intel's ICH7R accompanies the 955X on the GA-8I955X. The ICH7R adds support for SATA II and supports RAID 0, 1, 0+1, and 5 across its four SATA

DPS (Universal-Plus Dual Power System). According to Gigabyte, the U-PLUS DPS is supposed to provide cleaner power to the processor for added stability, but it does tend to clutter the motherboard a bit. The card slides into a slot located between the processor and motherboard's rear I/O panel. The U-PLUS DPS's copper heatpipe tends to add a bit of congestion around the northbridge heatsink.

BIOS. Luckily, Gigabyte motherboards include a backup BIOS. The system switched over to the backup BIOS and allowed us to boot using the old BIOS. We accessed the Q-Flash utility from the system's CMOS Setup Utility and were able to successfully update the BIOS from a floppy drive. With the new BIOS in place, we ran through our benchmarks to get some baseline scores.

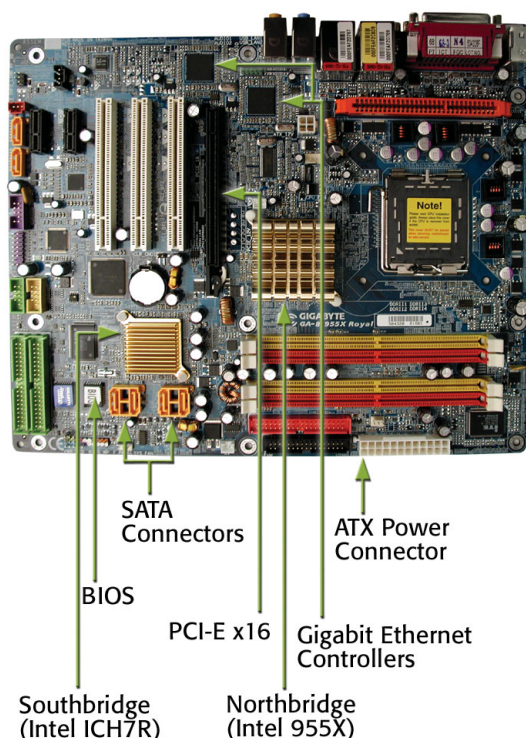
The GA-8I955X Royal didn't do a bad job from a performance standpoint. Our initial numbers were just slightly below those posted by the ASUS P5AD2-E in our previous article. The GA-8I955X posted a 3651 3DMark05 score and a 5350 PCMark04 score. Our 3.4GHz P4 EE managed a 5054 CPU score, which was well below the 5236 and 5152 scores posted by the ASUS P5AD2-E Deluxe and MSI 925X Neo Platinum boards in our last two case studies. The 4447 Graphics score was also a bit lower than the P5AD2-E. The 5329 Memory score and 4574 HDD score were nearly identical to the scores posted by the P5AD2-E.

The GA-8I955X posted the best frame rates of any board we tested the 3.4GHz P4 EE with. The board managed to churn through 51.17fps in Half-Life 2. Our 39.5fps in Doom 3 was also slightly faster than our previous stock scores.

After recording our baseline scores, we rebooted the system and accessed the Setup Utility. Overclocking options are located under the MB Intelligent Tweaker (M.I.T.) option. To adjust the FSB, we had to change CPU Host Clock Control to Enabled. Once enabled we selected CPU Host Frequency (MHz) and entered 210. This change will increase the processor's clock speed to 3.57GHz. Without making further changes in this section, we were able to increase our 3DMark05 score slightly to 3665. We increased the FSB again to 220MHz, but made no other changes. With the processor running at 3.74GHz, the system managed 3677 3DMark05 score.

As in the two previous case studies, we were unable to get the system stable at 230MHz. We tried increasing the PCI-E frequency and even increased the processor, memory, chipset, and PCI-E voltages, but nothing managed to stabilize the system. Considering this processor hasn't overclocked well at all, we weren't surprised.

We decreased the FSB to 225MHz, leaving our CPU voltage set to 1.6000V,



and managed to boot the system. Unfortunately, 3DMark05 caused the system to reboot during its first test. We decreased the FSB again to 223MHz, leaving our CPU voltage at 1.6000V, and this time managed to get a 3685 in 3DMark05. At 224MHz, 3DMark05 caused the system to reboot. We returned the FSB to 223MHz and ran PCMark04 and both our games. Scores were strong, but mixed. The overall PCMark04 score increased to 5889, better than either of the two boards we

looked at previously thanks to a strong 5865 Memory score. The 5618 CPU score was the lowest overclocked CPU score in this bunch, as was the 4451 Graphics score.

We saw little headway when it came to frame rates. Doom 3 frame rates increased to 39.9fps. Half-Life 2 frame rates increased to 51.58fps, which turned out to be the best score posted by the 3.4GHz P4 EE.

Final Word

Our Gigabyte board sported the best overclock of any board we tested the 3.4GHz Pentium 4 Extreme Edition with. We obtained scores with the processor running at 3.79GHz, about 20MHz faster than the 3.77GHz we managed with the MSI 925X Neo Platinum and 50MHz better

than the ASUS P5AD2-E Deluxe. The overclock, however, didn't mean much, as the P5AD2-E managed to beat the GA-8I955X's overclocked 3DMark05 scores at stock speeds. The GA-8I955X's support for faster memory helped it snare the best overall PCMark04 score despite posting the lowest overclocked CPU score.

Again, compared to the other 955X-based boards we tested our Pentium 4 640 on, the 3.4GHz P4 EE provided some very disappointing scores. The 3651 stock 3DMark05 score was actually two points lower than the stock 3DMark05 score posted by the P4 640. The 3.4GHz P4 EE did post better stock PCMark04 scores, but all of the P4 640's overclocked scores blew away anything that the 3.4GHz P4 EE could manage. Of course, the P4 640 overclocked much better than the 3.4GHz P4 EE, allowing us to reach a processor clock speed of 4.36GHz on a 270MHz FSB. Considering that the 3.4GHz P4 EE doesn't offer much more than the P4 640 in terms of cache, it's no wonder the P4 640 is blowing it out of the water. Our only question then is: What exactly are users paying for when they pick up an Extreme Edition processor? **CPU**

by Chad Denton

Overclock Comparison 3DMark05

MSI 925X Neo Platinum

Stock Performance	3601
Overclocked Performance	3659

ASUS P5AD2-E Deluxe

Stock Performance	3688
Overclocked Performance	3697

★ Gigabyte GA-8I955X Royal

Stock Performance	3651
Overclocked Performance	3685

Intel 3.46GHz Pentium 4 Extreme Edition & MSI P4N Diamond

Up to this point, we haven't run our 925XE and 955X boards at their fullest potential. Both chipsets include support for Intel's new 1,066MHz FSB, but because the Pentium 4 640 and 3.4GHz Pentium 4 Extreme Edition processors run on an 800MHz FSB, we couldn't test the faster bus speed in our previous articles.

The 3.46GHz Pentium 4 Extreme Edition is the perfect place to start testing the new 1,066MHz FSB. Aside from running on a faster FSB, the 3.46GHz P4 EE is almost identical to the 3.4GHz P4 EE we examined previously. Both processors use a 0.13-micron fabrication process, both processors include 2MB of L3 cache, and both processors run in the 1.525 to 1.6V range. If there are any performance benefits from the new bus, these two processors should help us detect them.

Motherboard

Normally, we test a new processor with an Intel 925X-based motherboard before moving on to 925XE and 955X boards.

Intel-based systems. Unlike Athlon 64s, Pentium processors lack an integrated MCH, so NVIDIA had to resort to separate northbridge and southbridge chipsets. The nForce4 SLI Intel Edition northbridge supports up to 16GB of DDR2 memory running at frequencies as high as 667MHz. The chipset supports two PCI Express x16 slots for video cards, but the second slot can also accommodate other PCI-E peripherals.

The MCP04 southbridge supports more peripherals than Intel's ICH6 or ICH7 chips: Ten USB ports and two IDE channels that can support a total of four drives, while Intel's ICH6 and ICH7 support eight USB ports and only one IDE channel. The MCP04 also supports four SATA II ports, a Gigabit Ethernet port, and RAID 0, RAID 1, RAID 0+1, RAID 5, and JBOD on both the SATA ports and the IDE ports. The P4N Diamond also includes a second Silicon Image SATA II controller that supports up to two SATA drives.

In addition to the NVIDIA Gigabit LAN, the P4N Diamond also includes a

System Specs

Processor, Motherboard & Drivers	
Processor	Intel 3.46GHz Pentium 4 Extreme Edition
Motherboard	MSI P4N Diamond
BIOS	
Manufacturer	American Megatrends
BIOS Version	v3.0
Chipset Driver	NVIDIA 7.03
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800
Common Components	
Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

variables made the P4N Diamond a difficult board. If you've used MSI's Web site to look for software updates, you know how horribly it's designed. Instead of grouping together driver updates according to each motherboard model, MSI groups its drivers by hardware category. Thus, audio drivers for all motherboards are lumped together on a single Web page, and you have to hunt down the driver that applies to the specific hardware on your motherboard. Good luck with that.

Intel 3.46GHz Pentium 4 Extreme Edition & MSI P4N Diamond

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.46GHz	266MHz	13X	1.5625V	5494	5280	6198	4458	4883	3662	39.5fps	51.75fps
Overclocked Performance	3.87GHz	298MHz	13X	1.6625V	5977	5883	6881	4466	4884	3674	39.9fps	51.88fps

The 925X, however, lacks support for the new 1,066MHz FSB, so we'll need another chipset to take its place. NVIDIA's nForce4 SLI Intel Edition chipset not only supports SLI on Intel-based systems, but it also supports the 1,066MHz FSB we need to test our 3.46GHz P4 EE.

Although they support similar features, NVIDIA had to make some changes to its nForce4 design to make it compatible with

Marvell 88E8053 PCI-E Gigabit Ethernet controller. Creative's Sound Blaster CA0106 provides 7.1-channel surround sound and includes support for a coaxial and optical SPDIF output. You'll also find a FireWire port on the back I/O panel.

Performance

Sometimes overclocking a system is easy, but not this time. A number of

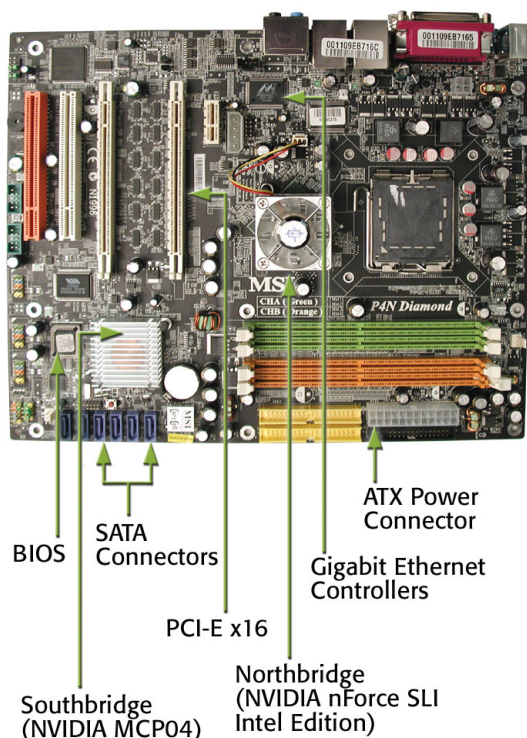
To speed the process along, we decided to install the drivers from the included CD-ROM and then run the included Live Update utility to check the Web for updated drivers. The software didn't find any updates, so we continued on with our testing, using the BIOS and drivers that shipped with the system. After a difficult time overclocking the motherboard, we finally got our scores and thought we were

finished. As we were double-checking our BIOS revision, we noticed that despite what the Live Update utility said, a BIOS update *was* available for the P4N Diamond on MSI's Web site. We lost a day's worth of work, as we installed the new drivers and started from scratch.

The new BIOS and drivers helped improve our default 3DMark05 score from 3642 to 3662, but our PCMark04 scores fell slightly. Our overall PCMark04 score fell from 5573 to 5494, thanks to a CPU score that fell from 5357 to 5280. Meanwhile, the other PCMark04 component scores were all pretty similar. We managed a 6198 Memory score, a 4458 Graphics score, and a 4883 HDD score. The HDD score was a little higher than we usually see from Intel's ICH6 controllers.

After recording our scores, we rebooted the system and pressed DELETE to enter the CMOS Setup Utility. Overclocking options are located in the Cell_Menu. We selected the System Clock Mode, pressed ENTER, and selected Manual to overclock both our FSB and memory manually. The other System Clock mode, Link, automatically overclocks memory based on your FSB speed. We used Manual to retain as much control as possible.

Next we increased the FSB from 1,066MHz to 1,100MHz. Here you'll notice a big difference in the way Intel-based chipsets and nForce4 chipsets display the FSB speed. Intel systems display the actual FSB (in this case that would be 266MHz instead of 1,066MHz). The actual FSB is quad-pumped on Intel systems to produce an effective FSB that's four times greater than the actual FSB. Instead of listing the actual FSB (266MHz), the nForce4 board lists the effective FSB (1,066MHz). We'll use multiples of four when adjusting the bus to keep settings consistent with Intel boards and we'll use actual FSB speeds in our charts.



At the board's default 1,066MHz FSB speed, our memory was running at 667MHz by default. To keep the relationship between memory speed and FSB speed consistent, we adjusted our memory speed to 687MHz and left all other settings unchanged, pressed ESC to return to the main menu, and selected Save & Exit Setup to save and reboot.

The increase bought us only a 2-point increase in our 3DMark05 performance. We increased the FSB to 1,140MHz and

Overclock Comparison 3DMark05

★ MSI P4N Diamond

Stock Performance	3662
Overclocked Performance	3674

ASUS P5AD2-E Deluxe

Stock Performance	3698
Overclocked Performance	3733

ASUS P5DW2 Premium

Stock Performance	3818
Overclocked Performance	3830

the Memory Frequency to 712MHz. At this speed, our 3DMark05 score *dropped* to 3659. We pumped the motherboard up to 1,180MHz and the memory frequency to 737MHz, but the PC rebooted while running 3DMark05. We stabilized the system by selecting Voltage Control Function, pressing ENTER and then using PAGE UP and PAGE DOWN to adjust the CPU Voltage to +75mV. We also set Adjust DDR Voltage to 1.95V and then rebooted.

With the processor now running at 3.84GHz, we managed a 3663 3DMark05 score. Not quite as good as the 3664 score we managed earlier, but an improvement. We bumped the FSB speed to 1,220MHz, but were unable to get the system stable no matter what

adjustments we made. We had to decrease the FSB to 1,192MHz (equating to a 298MHz actual FSB), set the memory frequency to 745MHz, and increase the CPU voltage to +100mV in order to get the system stable. Our 3.87GHz processor managed to post a much-improved 3674 with these settings in place.

Our modest overclock produced modest PCMark04 improvements, with an overall increase of almost 500 points to 5977. The CPU score increased to 5883, but the Memory score increase was the most dramatic: a 6881. Graphics and HDD scores were largely unchanged at 4466 and 4884. We managed 39.9fps in Doom 3 and 51.88fps in Half-Life 2.

Final Word

That second PCI-E video slot doesn't look very attractive if the nForce4 can't keep up with Intel-based chipsets. As you'll see, however, the nForce4 kept pace with the best Intel has to offer. We'll wait to look at the other two boards before deciding just what effect the new 1,066MHz FSB has on performance. **CPU**

by Chad Denton

Intel 3.46GHz Pentium 4 Extreme Edition & ASUS P5AD2-E Deluxe

The 3.46GHz Pentium 4 Extreme Edition put up some impressive numbers on the nForce4 SLI Intel Edition MSI P4N Diamond we looked at previously. Now let's see how the nForce4 scores stand up to Intel chipsets, as we test the board on an Intel 925XE chipset.

Motherboard

Originally, we had planned to use Foxconn's 925XE7AA-8EKRS2 motherboard. Although the board is based on Intel's 925XE chipset and thus is capable of running our 3.46GHz P4 EE, we were unable to get the system to even complete its POST with the processor installed. We experienced similar problems with our 3.73GHz P4 EE and our 3.4GHz P4 EE. The Foxconn board, however, had no problems running our Pentium 4 640.

We substituted the ASUS P5AD2-E Deluxe for the Foxconn board. Like the Foxconn board, the P5AD2-E includes an Intel 925XE chipset, which supports the 1,066MHz FSB that the 3.46GHz P4 EE needs to run. Aside from support for the

two additional IDE channels. According to the included manual, you can utilize these additional IDE channels for legacy optical drives as well as hard drives.

A C-Media CMI9880 provides 7.1-channels of high definition audio. The included audio jacks let you connect a 7.1-channel speaker system directly to your PC, or you can connect the system to an external tuner using either the coaxial or optical SPDIF outputs. A Texas Instruments FireWire 400 controller supports up to two FireWire 400 ports. One port is available on the rear I/O panel, and the second is available via a removable bracket.

Performance

After installing the latest BIOS update and drivers, we ran each benchmark using the motherboard's default settings. Scores were comparable to those of the MSI P4N Diamond in the previous article. Our 5369 PCMark04 score was slightly lower than that of the MSI board, thanks primarily to the 5775 Memory score. The 5263 CPU score didn't trail that of the MSI board

System Specs

Processor, Motherboard & Drivers	
Processor	Intel 3.46GHz Pentium 4 Extreme Edition
Motherboard	ASUS P5AD2-E Deluxe
BIOS	
Manufacturer	American Megatrends
BIOS Version	0302
Chipset Driver	Intel 7.0.0.1009
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800
Common Components	
Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200RPM
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

slightly better frame rates in Doom 3 and Half-Life 2. We managed 40.2fps in Doom 3 and 51.03fps in Half-Life 2.

We were a little disappointed that we couldn't get the Foxconn board we had originally planned to use working with our Extreme Edition processors. However, reusing the P5AD2-E here provided an interesting opportunity to see how the new 1,066MHz FSB affects performance. We used this same board with a nearly identical processor, the 3.4GHz Pentium

Intel 3.46GHz Pentium 4 Extreme Edition & ASUS P5AD2-E Deluxe

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.46GHz	266MHz	13X	1.5625V	5369	5263	5775	4527	4592	3698	40.2fps	51.03fps
Overclocked Performance	3.95GHz	304MHz	13X	1.5625V	6118	5904	6398	4633	4564	3733	40.7fps	51.60fps

faster FSB, there's not a lot difference between the 925XE and Intel's 925X.

In addition to the 925XE on the northbridge, the P5AD2-E includes Intel's ICH6R on the southbridge. The ICH6R supports RAID 0 and 1 configurations on four SATA ports. The ICH6R also supports eight USB ports and a single IDE channel for up to two legacy IDE drives. The ITE 8212F IDE controller provides

by much, and the ASUS board's 4527 Graphics score was actually slightly better than the MSI board's score. The P5AD2-E managed a 4592 HDD score, which is about typical for Intel's ICH6 southbridge, but slightly lower than the score posted by the MCP04 southbridge that accompanies NVIDIA's nForce4 board. In 3DMark05, however, the ASUS board carried the day with its 3698. The P5AD2-E also provided

4 Extreme Edition, previously. The current 3.46GHz P4 EE we're using in this article has a slight clock speed advantage, but not enough to make a huge difference.

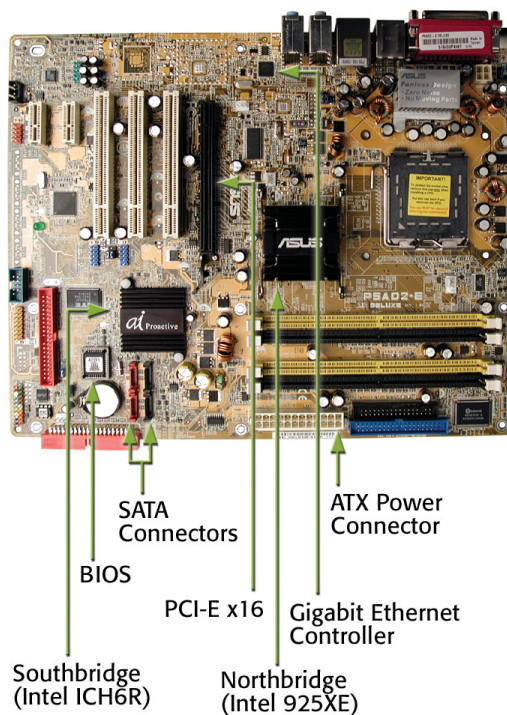
We didn't see a huge difference in terms of performance between the two processors. The 3.4GHz P4 EE actually managed a slightly higher overall PCMark04 score, edging out the 3.46GHz P4 EE by 19 points. The 3.46GHz P4 EE held a slight

advantage, however, in every PCMark04 component score. The 3.46GHz P4 EE managed a 27-point higher CPU score, a 23-point higher Graphics score, and a 15-point higher HDD score. Naturally, the faster FSB speed had its greatest influence on the Memory score, where the 3.46GHz P4 EE scored 454 points better than the 3.4GHz P4 EE. In 3DMark05, however, the memory boost didn't amount to a whole lot. The 3.46GHz P4 EE managed just 10 points better than the 3.4GHz P4 EE. In Doom 3 and Half-Life 2, the faster FSB couldn't even buy an extra half-frame per second. Doom 3 frame rates increased just 0.4fps, and Half-Life 2 frame rates increased just 0.39fps.

After recording our initial scores, we rebooted the system and pressed DELETE to enter the system setup utility and used the arrow keys to select the Advanced tab along the top of the screen. We then selected JumperFree Configuration and pressed ENTER. This screen displays all the relevant overclocking options. To increase the FSB, we simply selected CPU Frequency and entered **280** to increase the FSB from 266MHz to 280MHz (and to increase the processor clock speed to 3.64GHz in the process). We adjusted our Memory Frequency to 560MHz to keep it consistent with ratio used at default clock speeds. We set the Performance Mode option to Standard, saved our settings, and rebooted. The resulting speed increase allowed us to break the 3700 barrier in 3DMark05 with a 3717 3DMark05 score.

Increasing the FSB to 290MHz resulted in 3DMark05 scores falling to 3709. We upped the CPU voltage to 1.7250V, but performance fell further, to 3703. Increasing the voltage to 1.7500V created a slight upswing to 3707. Although it still wasn't where we wanted it, we hoped an FSB increase would result in better scores.

We increased the FSB another 10MHz to 300MHz. Although the system booted,



to 1.90V, our chipset core voltage to 1.60V, our FSB termination voltage to 1.25V, and CPU voltage to 1.8000V. The result: a 3733 3DMark05 score.

PCMark04 scores also saw a strong improvement. Our overall PCMark04 score increased to 6118, thanks to substantial increases in both the CPU score (5904) and Memory score (6398). We also saw a slight improvement in our Graphics score, as it increased to 4633. Our HDD score re-mained largely unchanged at 4564. We did pick up more than one frame per second in Half-Life 2, with our score increasing to 51.60fps, but Doom 3 frame rates only increased slightly to 40.7fps.

Final Word

We're not sure if it was the faster FSB or simply a more forgiving processor, but for whatever reason we were able to reach faster clock speeds on this board with the 3.46GHz P4 EE than the 3.4GHz P4 EE. The 3.4GHz P4 EE running on an 800MHz FSB with a 17X multiplier was only able to reach 3.74GHz on the P5AD2-E, while we were able to get our 3.46GHz P4 EE up to 3.95GHz using its 13X multiplier and default 1,066MHz FSB. As you can imagine, the faster FSB combined with the higher processor clock speed secured more impressive scores for the overclocked 3.46GHz P4 EE.

Compared to the nForce4-based MSI P4N board we looked at in our last case study, the P5AD2-E looked to be a little better. PCMark04 scores were higher across the board for the MSI P4N Diamond, but the P5AD2-E posted a better 3DMark05 score. We were more successful overclocking the 3.46GHz P4 EE on the P5AD2-E, resulting in better overclocked scores in most categories, but the P4N Diamond's SLI capabilities make it a little easier to overlook the discrepancies. **CPU**

by Chad Denton



3DMark05 crashed during testing. We increased the CPU voltage to 1.7750V. This stabilized the system and delivered a 3713 3DMark05 score. We were unable to get the system stable at 310MHz, so we decreased the FSB and adjusted a few additional settings. Finally, we managed to get the system stable at 304MHz. This left the processor just shy of 4GHz at 3.95GHz and our memory frequency at 608MHz. We increased our PCI-E frequency to 106MHz, our memory voltage

Overclock Comparison 3DMark05

MSI P4N Diamond

Stock Performance	3662
Overclocked Performance	3674

★ ASUS P5AD2-E Deluxe

Stock Performance	3698
Overclocked Performance	3733

ASUS P5DW2 Premium

Stock Performance	3818
Overclocked Performance	3830

Intel 3.46GHz Pentium 4 Extreme Edition & ASUS P5WD2 Premium

So far, we've looked at two motherboard/processor combinations that run on the new 1,066MHz FSB, and so far, we've been less than impressed. 3DMark05 scores have generally been higher, but not by a significant amount. We've seen more increase in PCMark04 scores, but none of the increases translate into a big difference when it comes to Doom 3 or Half-Life 2. This time around, we'll be testing our 3.46GHz Pentium 4 Extreme Edition on the ASUS P5WD2 Premium.

Motherboard

This isn't the first time we've seen the P5WD2. This board gave us phenomenal scores with the Pentium 4 640 we looked at previously. We're forced to reuse it because at the time we ordered parts for this issue, Gigabyte and ASUS were the only manufacturers with 955X motherboards readily available.

The P5WD2 includes Intel's 955X chipset. Like the 925XE, the 955X includes

On its southbridge, the P5WD2 uses Intel's new ICH7R. The ICH7R includes support for SATA II, as well as RAID 0, RAID 1, RAID 5, and RAID 10 support. The ICH7R only supports two IDE drives on a single channel. A second ITE IDE controller provides two additional IDE channels, however, do not support ATAPI devices such as optical drives. They're reserved exclusively for legacy IDE hard drives. A Silicon Image 3132 provides two additional SATA II ports. One port resides between the processor and back I/O panel, while the second port is located on the back I/O panel and accepts an external SATA II drive. With an external drive connected, the Sil 3132 can support RAID 0 and RAID 1.

A Marvell 88E8001 provides Gigabit Ethernet over the PCI bus. An Intel Gigabit LAN controller is also included and it utilizes the faster PCI-E bus and should, theoretically, provide better throughput. A Realtek ALC882D provides

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.46GHz Pentium 4 Extreme Edition
Motherboard	ASUS P5WD2 Premium
BIOS	
Manufacturer	American Megatrends
BIOS Version	1010
Chipset Driver	7.0.0.1019
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

at the motherboard's default settings. The board managed to post an impressive 3818 in 3DMark05, a score that was higher than any stock 3DMark05 score and second only to the 3900 3DMark05 score we received when testing this same board with our overclocked Pentium 4 640. PCMark04 scores were less impressive, but still strong. The 5459 overall PCMark04 score was better than that of the 925XE-based ASUS P5AD2-E we looked at previously, but not quite as good

Intel 3.46GHz Pentium 4 Extreme Edition & ASUS P5WD2 Premium

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.46GHz	266MHz	13X	1.5625V	5459	5318	5758	4855	4562	3818	40.9fps	53.11fps
Overclocked Performance	3.86GHz	297MHz	13X	1.8000V	5883	5842	6143	4931	4607	3830	41.6fps	53.48fps

support for the 1,066MHz FSB that our 3.46GHz P4 EE requires to run. The 955X also supports Intel's Pentium D processor, which features two Pentium 4 cores on a single die. We'll take a closer look at Intel's high-end dual-core Pentium 840 Extreme Edition processor in the "Race For The Gold" article (see page 98 in this issue). For now, we'll just be content to see what the P5WD2's 1066Mhz FSB is capable of.

7.1-channel surround sound and supports coaxial and optical SPDIF outputs. A TI controller supports two FireWire 400 ports, one located on the rear I/O panel and a second via an included bracket or a FireWire port integrated into your case.

Performance

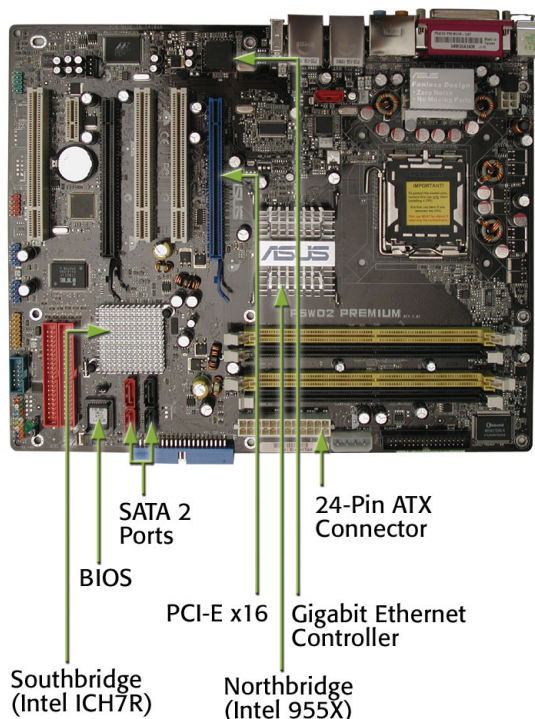
After updating the BIOS and installing the latest drivers, we ran each benchmark

as the score posted by the nForce4-based MSI P4N Diamond. The 5318 CPU score was strong, and the 5758 Memory score was decent, but the 4855 Graphics score was significantly higher than we typically see in our testing. The 4562 HDD score, on the other hand, was well below HDD scores posted by the MCP04 southbridge that's included on nForce4 systems. The P5WD2's Doom 3 and Half-Life 2

frame rates were better than the overclocked frame rates posted by the two previous boards (albeit not by much). We managed 40.9fps in Doom 3 and 53.11fps in Half-Life 2.

After running our last test, we rebooted the system and pressed DELETE to enter the CMOS Setup Utility. We used the arrow keys to select the Advanced tab at the top of the screen and then selected JumperFree Configuration. In order to adjust the FSB, we had to set the AI Overclocking option to Manual. Once selected, a number of new options, including CPU Frequency, appear in the menu. We selected CPU Frequency and entered **280** to increase the FSB speed from 266MHz to 280MHz. By default, our memory was running at 533MHz. To maintain the same relationship to our FSB, we selected DRAM Frequency and set it to DDR2-560MHz. We pressed ESC to exit to the main menu and then selected Save Settings & Exit from the main menu.

With our processor now running at 3.64GHz, we managed to post a 3831 3DMark05 score. Increasing the FSB to 290MHz resulted in a drop in performance, as 3DMark05 returned a score of just 3814. We increased the CPU VCore Voltage in the CMOS to 1.7000V to help with performance as we increased the FSB to 300MHz. The system remained unstable at this speed, even after we increased the memory voltage to 2.00V, the FSB Termination voltage to 1.40V, the north-bridge voltage to 1.55V, and the south-bridge voltage to 1.21V. We also tried increasing the PCI-E frequency to 110MHz. None of the changes seemed to make a difference, so we backed off a bit, dropping our FSB speed back down to 295MHz but leaving our voltage changes intact. With that configuration, we managed to score a 3828 in 3DMark05, which was an improvement over our last score but still short of our best score. 3DMark05 crashed with the FSB set to



298MHz, so we decreased it to 297MHz and managed a 3830 3DMark05 score.

With the modest increase in clock speed from 3.46GHz to 3.86GHz, we weren't expecting much in the way of large increases to our benchmark scores. Our overall PCMark04 score increased more than 400 points to 5883, well below the dramatic increase we saw in our previous article. The CPU score increased by more than 500 points to 5842 and the Memory score increased nearly 400

points to 6143. The Graphics score saw a modest increase to 4931 while the HDD score saw an even smaller increase to 4607. Doom 3 and Half-Life 2 showed small improvements to 41.6fps and 53.48fps, respectively. Once again, our game frame rates were better than we managed with any of the previous two boards. True, the gap is relatively small, but there's never a very large gap in frame rates, so even a few tenths of a frame per second can make a difference.

Final Word

In light of how well this board performed with the Pentium 4 640, we were a little disappointed that we couldn't get the 3.46GHz Pentium 4 running faster than we did.

Of course, the 0.13-micron transistor size employed by the 3.4GHz P4 EE and 3.46GHz P4 EE doesn't leave as much headroom as the newer 90nm transistor size used by the Pentium 4 640 and the 3.73GHz Pentium 4 Extreme Edition that we'll examine next.

Although we weren't terribly impressed with its overclocking performance, we were impressed with the 3DMark05, Doom 3, and Half-Life 2 numbers posted by this board. They managed to soundly beat anything that our two previous boards could muster. The PCMark04 scores were a little low in places, with the nForce4-based MSI P4N Diamond capturing the best overall PCMark04 score in this group.

Compared to the 3.4GHz P4 EE CPU, which uses an 800MHz FSB, the 3.46GHz P4 EE seemed to post higher scores, but the difference was fairly minimal. The extra FSB bandwidth helped CPU and Memory scores in PCMark04, but it didn't seem to matter much when it came to 3DMark05 scores. **CPU**

by Chad Denton

Overclock Comparison 3DMark05

MSI P4N Diamond

Stock Performance	3662
Overclocked Performance	3674

ASUS P5AD2-E Deluxe

Stock Performance	3698
Overclocked Performance	3733

★ ASUS P5DW2 Premium

Stock Performance	3818
Overclocked Performance	3830

Intel 3.73GHz Pentium 4 Extreme Edition & ASUS P5ND2-SLI Deluxe

The 3.46GHz Pentium 4 Extreme Edition we looked at in the last three case studies was our first look at Intel's new 1,066MHz FSB. The speed increase pepped up PCMark04 scores, but 3DMark05 and game scores were only up slightly compared to the 3.4GHz Pentium 4 Extreme Edition (which runs on an 800MHz FSB) that we looked at earlier. Now it's time to see what a higher multiplier will do for us as we examine Intel's 3.73GHz Pentium 4 Extreme Edition.

Actually, the difference between the 3.73GHz P4 EE and the 3.46GHz P4 EE is greater than mere clock speed. The 3.73GHz P4 EE is based on Intel's new 90nm fabrication process, which means it should have a little more headroom for overclockers. Intel also nixed the L3 cache normally associated with its Extreme Edition line. Instead, the company expanded the processor's L2 cache from 512KB to 2MB. Factor in support for Intel's EM64T extensions for 64-bit computing, and the 3.73GHz P4 EE looks a

board's nForce4 SLI Intel Edition chipset supports the new 1,066MHz FSB speed. In fact, like the 955X, the nForce4 SLI will even support dual-core Pentium D processors (although the Pentium D 820 will only operate as a single core). Throw in SLI, and what more can you ask for?

As with the MSI P4N Diamond, the P5ND2-SLI includes two PCI-E X16 slots for graphics cards (although both slots operate at X8 when running in SLI mode). In order to use SLI, you need to remove a small card installed parallel to the motherboard, invert the card, and then reinsert it. It's not a difficult task, but it is a little more work than the P4N Diamond requires.

On the southbridge is NVIDIA's MCP04, which supports four SATA II ports, as well as RAID 0, RAID 1, RAID 0+1, RAID 5, and JBOD. In addition, the MCP04 supports two IDE channels for up to four IDE legacy drives. A Silicon Image 3132 SATA controller supports one additional SATA II internal

System Specs

Processor, Motherboard & Drivers	
Processor	Intel 3.73GHz Pentium 4 Extreme Edition
Motherboard	ASUS P5ND2-SLI Deluxe
BIOS	
Manufacturer	American Megatrends
BIOS Version	0708
Chipset Driver	NVIDIA 7.13
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800
Common Components	
Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200RPM
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

ALC850 provides 7.1 channels of high-definition audio. Coaxial and optical SPDIF outputs are located on the rear I/O panel for plugging the system into an external receiver. Finally, the board's two Gigabit Ethernet ports are powered by an Intel 82540EM Gigabit LAN controller and NVIDIA's nForce4 chipset.

Performance

We initially had some problems getting this board up and running. Although our memory was rated as DDR2-800, we

Intel 3.73GHz Pentium 4 Extreme Edition & ASUS P5ND2-SLI Deluxe

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.73GHz	266MHz	14X	1.344V	5933	5742	6392	4444	4882	3686	39.8fps	50.99fps
Overclocked Performance	4.21GHz	301MHz	14X	1.344V	6578	6473	6967	4467	4867	3721	40.3fps	51.67fps

lot like the Pentium 4 640 we examined earlier. The biggest difference between the two processors is the FSB. Like the 3.46GHz P4 EE, the 3.73GHz P4 EE runs on a 1,066MHz FSB instead of the 800MHz FSB used by the P4 640.

Motherboard

This time around we snagged the ASUS P5ND2-SLI Deluxe motherboard. This

drive and one external SATA II drive (although you'll need to find a way to power the external drive). RAID 0 and RAID 1 are supported when an external and internal drive are present.

A TI 1394 controller provides FireWire 400 via the FireWire port on the rear I/O panel. A bracket with a second FireWire port (which plugs into the motherboard header) comes with the package. A Realtek

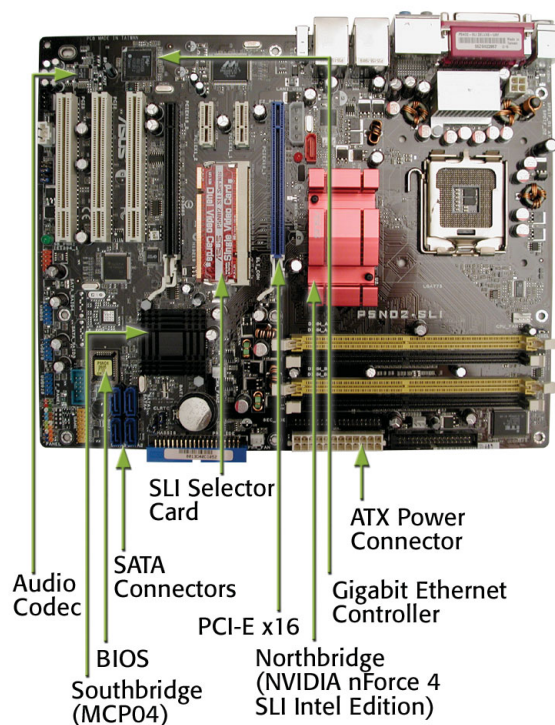
seemed to encounter some problems when the system actually ran the memory at 800MHz (which it did by default). As a result, we couldn't get Windows installed on the test system until we reduced the memory frequency to 667MHz.

After we finally got the proper drivers loaded and installed the latest BIOS revision, we began our testing. We started off with a 3DMark05 score of 3686. Our

overall PCMark04 score of 5933 was the best stock score posted by the 3.73GHz P4 EE, thanks to a 5742 CPU score and a 6392 Memory score. The MCP04 seems to post consistently better HDD scores than do Intel's ICH6 or ICH7, as the P5ND2-SLI posted a 4882. The 4444 Graphics score was below average. We managed 39.8fps in Doom 3, which wasn't bad. Half-Life 2, on the other hand, posted a disappointing 50.99fps.

After recording the last score, we rebooted the system and pressed DELETE to enter the CMOS Setup Utility. We used the arrow keys to select the Advanced tab at the top of the screen and then pressed ENTER to select JumperFree Configuration. Before we could modify the FSB, we needed to set the Overclock Profile to Manual. After making the change, the Frequency Control, Spread Spectrum Control, and Voltage Control options all become available. We started by selecting the Frequency Control section and changing the System Clock Mode to CPU/MEM Manual Mode. In this mode we have control over both the FSB speed and the memory frequency. After making the selection, we were able to change New FSB Speed (MHz) from 1,066MHz to 1,120MHz. Next, we changed New MEM Speed (MHz) to 560MHz in order to gain some headroom for overclocking. We didn't need to change any additional options, so we simply pressed F10 to save our changes and reboot the system.

With the processor now running at 3.92GHz, we were able to post a 3689 3DMark05 score. Next we increased the FSB to 1,160MHz and the memory frequency to 580MHz, resulting in a 3700 3DMark05 score. At the 1,200MHz mark, 3DMark05 crashed during testing, so we returned to the JumperFree Configuration menu in the CMOS and this time selected Voltage Control. This menu included a VCore Overvoltage 100mv option that we enabled. This setting provides a little extra



voltage without compromising some of the processor's power management features. This simple fix stabilized the system, yielding a 4.20GHz processor and a 3712 3DMark05 score.

We tried to get the system running at 1,240MHz but had no luck. Unfortunately, increasing the processor's core voltage seemed to cause more problems than it solved, as Windows flashed a blue screen and then rebooted whenever we changed the VCore Voltage option from Auto.

Increasing other component scores did nothing to stabilize the system, so we

began backing down the FSB. We had to come all the way down to 1,204MHz before we got a stable enough system to complete 3DMark05. At this speed, the processor was running at just 4.21GHz, just a tick higher than the last time we completed 3DMark05. Nonetheless, we did apply some extra voltage to some components. Our DRAM Voltage was set to +2.0V, our Chipset Core Voltage was set to +1.5V, our southbridge SATA Voltage was set to +1.6V, our CPU Termination Voltage was set to 1.40V, and our VCore Overvoltage 100mv was set to Enable. The VCore Voltage remained on Auto.

The extra voltage helped push our 3DMark05 score to 3721.

PCMark04 scores also showed marked improvements. Our overall PCMark04 score increased to 6578, thanks to 6473 and 6967 CPU and Memory scores. The Graphics score increased slightly, but not enough to make a huge difference at 4467, and the HDD drive score remained basically unchanged at 4867. Doom 3 and Half-Life 2 frame rates increased to 40.3fps and 51.67fps, respectively.

Final Word

While the nForce4 board holds its own against its competitors, the 3.73GHz P4 EE is looking pretty weak compared to the Pentium 4 640. Perhaps this shouldn't be much of a surprise. As we mentioned, there's little difference between the two processors, aside from FSB speed, and as we saw in the last three case studies, the new 1,066MHz FSB doesn't make a huge performance difference. When you consider that we were able to overclock the Pentium 4 640 beyond the 4.21GHz limit we encountered here, it's no surprise that this processor posted better all around overclock scores. That's worth keeping in mind when you consider that there's an \$800 price difference. **CPU**

by Chad Denton

Overclock Comparison 3DMark05

★ ASUS P5ND2-SLI Deluxe

Stock Performance	3686
Overclocked Performance	3721

ABIT AA8XE

Stock Performance	3650
Overclocked Performance	3699

Gigabyte GA-8I955X Royal

Stock Performance	3689
Overclocked Performance	3742

Intel 3.73GHz Pentium 4 Extreme Edition & ABIT AA8XE

In the previous case study, we had hoped the 90nm transistors in the 3.73GHz Pentium 4 Extreme Edition would provide added headroom for over-clocking. We were a little disappointed that we were only able to reach 4.21GHz, but that number isn't too bad, considering that the processor didn't want to accept any additional voltage. We're hoping the 925XE-based ABIT AA8XE provides a more stable overlocking platform.

Motherboard

We originally planned to pair our 3.73GHz P4 EE with MSI's 925XE Neo Platinum. Unfortunately, we damaged the board while overlocking the processor—ah, there's nothing like the smell of fried silicon. With the 925XE Neo Platinum on the disabled list, we turned to the ABIT AA8XE we had used earlier.

The 925XE that's at the heart of the AA8XE supports the 1,066MHz FSB that our 3.73GHz P4 EE runs on. It also supports 4GB of DDR2, but it only officially

you're limited to two IDE devices. Unlike some of our other boards, the AA8XE lacks additional storage controllers.

We found a single FireWire 400 port on the rear I/O panel. Two additional motherboard headers support two additional FireWire ports, and a Realtek RTL8110S provides Gigabit Ethernet support using the PCI bus, which could create a bit of a bottleneck at faster networking speeds. Finally, a Realtek ALC880 supports 7.1-channel surround sound and an optical SPDIF input and output.

Performance

In the previous case study, the 3.73GHz P4 EE put up some decent numbers, but considering its price, the performance was a little disappointing. After updating to the latest BIOS and drivers, we crossed our fingers and hoped the ABIT AA8XE would provide some better numbers.

Our default scores were still strong, but hardly what we'd call impressive. Our 3650 3DMark05 score was actually three

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.73GHz Pentium 4 Extreme Edition
Motherboard	ABIT AA8XE
BIOS	
Manufacturer	Award/Phoenix
BIOS Version	22
Chipset Driver	6.3.0.1007
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

case study, but not by much. The 4443 Graphics score and 4587 HDD score were exactly what we've come to expect. The 5742 Memory score was low compared to the 6392 Memory score posted in the previous case study. The difference is likely due to faster memory frequencies supported by the P5ND2-SLI. The P5ND2-SLI, for instance, ran the memory at 667MHz by default, while the AA8XE limits itself to just 533MHz.

Frame rates in Doom 3 and Half-Life 2 were average. Our 39.7fps Doom 3

Intel 3.73GHz Pentium 4 Extreme Edition & ABIT AA8XE

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.73GHz	266MHz	14X	1.3500V	5926	5720	5742	4443	4587	3650	39.7fps	50.33fps
Overclocked Performance	4.20GHz	300MHz	14X	1.3500V	6505	6429	6398	4666	4582	3699	42.2fps	50.94fps

supports memory frequencies up to 533MHz. Complementing the 925XE on the northbridge is Intel's ICH6R on the southbridge. The R in ICH6R, of course, indicates RAID, and the ICH6R supports RAID 0 and RAID 1 on its four SATA ports. The ICH6R also supports a single IDE channel for legacy hard drives or optical drives. Because the ICH6R only supports a single IDE channel, however,

points lower than the score posted by the Pentium 4 640 on the ASUS P5WD2 Premium. PCMark04 scores were more impressive, despite the fact that the ABIT AA8XE posted the lowest Memory score of any board we used to test the 3.73GHz P4 EE. Our overall PCMark04 score and CPU score were strong at 5926 and 5720. Both scores were lower than those posted by the ASUS P5ND2-SLI in the previous

frame rate was far from the lowest Doom 3 frame rate, but it also wasn't near the top. The same thing goes for the 50.33fps in Half-Life 2.

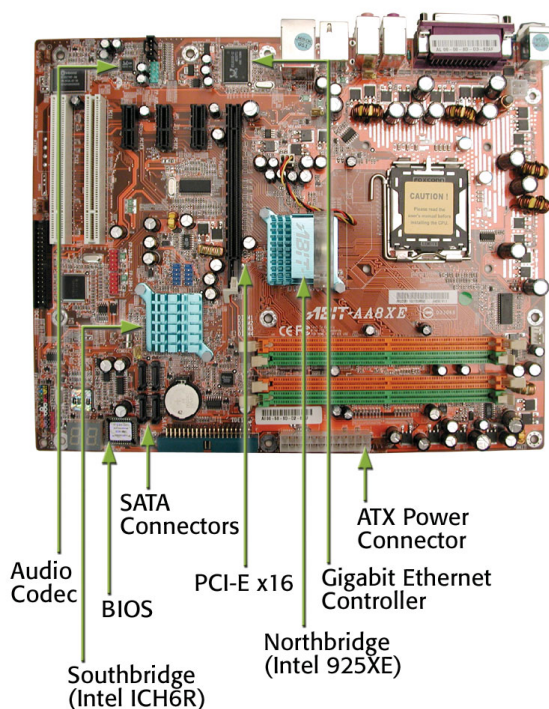
After recording the default scores, we rebooted the system and pressed DELETE during startup to access the system's CMOS Setup Utility. Overclocking options are found in the uGuru Utility section at the top of the main menu.

As we've previously noticed with other ABIT boards, our processor was running on a slightly over-clocked FSB (271MHz instead of 266MHz), resulting in a slightly faster 3.79GHz clock speed.

To increase the FSB further, we selected CPU Operating Speed and pressed PAGE UP to change it from 3724(266) to User Define. We selected External Clock and pressed PAGE DOWN to change the value from its 271MHz default speed to 280MHz. Next, we selected DRAM Frequency (CPU:DRAM) and changed the value to DDR533(1:1) by pressing PAGE UP. We left all other settings and pressed F10 to save our settings and exit.

With the processor running at 3.92GHz, our 3DMark05 score increased to 3668. Increasing the FSB to 290MHz caused a further increase to 3686. At 300MHz, however, 3DMark05 started crashing on us. Normally, we'd just increase the processor voltage to stabilize the system, but considering the problems we encountered in our previous case study when raising the CPU voltage, we decided to increase the PCI Clock from 33.33MHz to 36.36MHz. The change had the desired effect, netting us a 3DMark05 score of 3699.

We started running into more problems at 310MHz, as the system continually rebooted while loading Windows. Initially, we tried to increase the PCI Express Frequency by selecting PCI Express Clock in the uGuru Utility. We set the PCI-E frequency to 115MHz, but the change didn't stabilize the system. Increasing the PCI Clock to 40.00MHz didn't help things either, so we had no choice but to turn to the CPU voltage controls. We returned to the uGuru Utility and selected Voltage Control. We pressed PAGE UP to change its value from Auto Detect to User Define. Next, we selected CPU Core Voltage and increased it to 1.4250V. This time we came closer to loading Windows than on our two previous attempts. Next, we tried increasing the memory voltage and north-bridge voltage by setting DDRII SDRAM



Voltage and NB Voltage to 1.90V and 1.60V, respectively. This didn't help at all, so we increased the CPU voltage again to 1.4500V and then 1.4750V. Increasing the CPU voltage seemed to be helping and finally, with the CPU voltage set to 1.6250V, we at last managed to get a 3DMark05 score. Unfortunately, it was a woefully low 3560.

Occasionally, increasing the processor voltage can cause a low score to improve dramatically. Not this time. The more we increased the CPU voltage, the worse our scores got. We reset the motherboard to

the same settings we used to get our 3699 3DMark05 score, but increased the CPU voltage. We ended up with a 3635, suggesting that increased voltage, while not as catastrophic as in our last case study, was actually harming performance. We returned Voltage Control to Auto Detect in the setup utility and set the FSB to 301MHz. When 3DMark05 then refused to run, we reset the FSB to 300MHz and proceeded to run our additional benchmarks.

Our overall PCMark04 score had improved to 6505 and our CPU and Memory scores increased to 6429 and 6398, respectively. Neither score was as strong as the overclocked scores we saw in our last case study, but neither score was too disappointing, either. The Graphics score increased slightly to 4666, while our HDD score remained largely unchanged at 4582. We saw a subtle increase in Doom 3 and Half-Life 2 frame rates, as they increased to 42.2fps and 50.94fps, respectively.

Final Word

Compared to other test runs of the 3.73GHz P4 EE, the scores posted by our ABIT AA8XE weren't bad. However, the Pentium 4 640 we tested earlier still puts up a fight. Not only were we able to overclock the P4 640 further, but in some instances it posted better overclocked scores. On the same ABIT AA8XE used here, the Pentium 4 640 managed to reach a 4.28GHz clock speed and posted a 6637 overall PCMark04 score, a 6526 CPU score, a 6732 Memory score, and a 3738 3DMark05 score, all of which were better than the 3.73GHz P4 EE managed at 4.20GHz. The 3.73GHz P4 EE did manage a couple of extra frames per second in Doom 3, but Half-Life 2 scores were about one frame per second lower than the P4 640's overclocked Half-Life 2 score. Again, this is very disappointing, considering the price difference between the two processors. **CPU**

by Chad Denton

Overclock Comparison 3DMark05

ASUS P5ND2-SLI Deluxe

Stock Performance	3686
Overclocked Performance	3721

★ ABIT AA8XE

Stock Performance	3650
Overclocked Performance	3699

Gigabyte GA-8I955X Royal

Stock Performance	3689
Overclocked Performance	3742

Intel 3.73GHz Pentium 4 Extreme Edition & Gigabyte GA-8I955X Royal

So far, we've been a little bit disappointed in the performance of the 3.73GHz Pentium 4 Extreme Edition. While scores have generally been higher than the 3.46GHz Pentium 4 Extreme Edition, they haven't been significantly higher, and the processor's faster FSB speed hasn't translated into significant performance gains over the very similar Pentium 4 640. Perhaps our 955X-based motherboard can spark up performance a bit.

Motherboard

This time we'll pair up the 3.73GHz P4 EE with our 955X Gigabyte GA-8I955X Royal. Like the 925XE, the 955X provides support for the 1,066MHz FSB needed by our 3.73GHz P4 EE. The 955X also supports Intel's new dual-core processors. (See "Race For The Gold" on page 98 for a closer look at Intel's high-end dual-core processor.)

Accompanying the 955X northbridge is Intel's ICH7R on the southbridge.

provides RAID 0 or 1 support on two additional SATA II ports.

Two Broadcom Gigabit Ethernet controllers provide network connectivity, while a Realtek ALC882 audio codec provides the onboard audio features. The ALC882 supports a coaxial and an optical SPDIF output for connecting the system to a compatible surround sound receiver. A FireWire 800 controller provides support for up to three FireWire 800 ports. No ports are located on the rear I/O panel, but an included bracket provides two FireWire ports, leaving an extra header for any FireWire port located on the case.

As with many Gigabyte boards, the GA-8I955X includes Gigabyte's U-PLUS DPS (Universal Plus Dual Power System). The U-PLUS DPS mounts into a slot located between the processor and rear I/O panel. According to Gigabyte, the U-PLUS DPS supposedly provides cleaner power to the processor for more stable performance. Our motherboard also included an extra Bluetooth dongle

System Specs

Processor, Motherboard & Drivers

Processor	Intel 3.73GHz Pentium 4 Extreme Edition
Motherboard	Gigabyte GA-8I955X Royal
BIOS	
Manufacturer	Award/Phoenix
BIOS Version	F5
Chipset Driver	Intel 7.0.0.1025
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800

Common Components

Video	Chaintech GeForce 6600GT 128MB
Hard Drive	6Y160M0 160MB SATA 7,200rpm
Heatsink	Thermalright X-90-C Heatsink
CPU Fan	Zalman ZM-F1 80mm
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	Antec TruePower II 550W ATX
Case	Coolermaster Wave Master TAC-T01-E1C

the motherboard's 1,066MHz FSB, and once again, we generated some decent scores.

The 3689 3DMark05 score was the best stock 3DMark05 score posted by the 3.73GHz P4 EE (edging out the ASUS P5ND2-SLI by just three points). The overall PCMark04 score, however, was the *lowest* score posted by the 3.73GHz P4 EE, despite strong PCMark04 component scores. The 5754 PCMark04 CPU score was the highest for the 3.73GHz P4 EE, and the 6204 Memory score was

Intel 3.73GHz Pentium 4 Extreme Edition & Gigabyte GA-8I955X Royal

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.73GHz	266MHz	14X	1.3500V	5890	5754	6204	4420	4577	3689	39.6fps	51.26fps
Overclocked Performance	4.22GHz	303MHz	14X	1.3500V	6116	5582	6898	4456	4548	3742	40.2fps	51.36fps

The ICH7R supports SATA II and RAID 0, RAID 1, RAID 0+1, and RAID 5 over four SATA ports. Like its predecessor, the ICH6R, the ICH7R only supports a single IDE channel, limiting you to just two legacy IDE drives. An IT8212F IDE controller provides two additional IDE channels and supports RAID 0, 1, 0+1, and JBOD on connected hard drives. A Silicon Image 3132

to provide Bluetooth connectivity with notebooks, PDAs, phones, and other Bluetooth-enabled devices.

Performance

The last time we looked at Gigabyte's GA-8I955X Royal, it put up some impressive numbers while running Intel's 3.4GHz Pentium 4 Extreme Edition. This time around, we got to take advantage of

strong. The 4420 Graphics and 4577 HDD scores were also well within the norm. We managed 39.6fps in Doom 3 and 51.26fps in Half-Life 2.

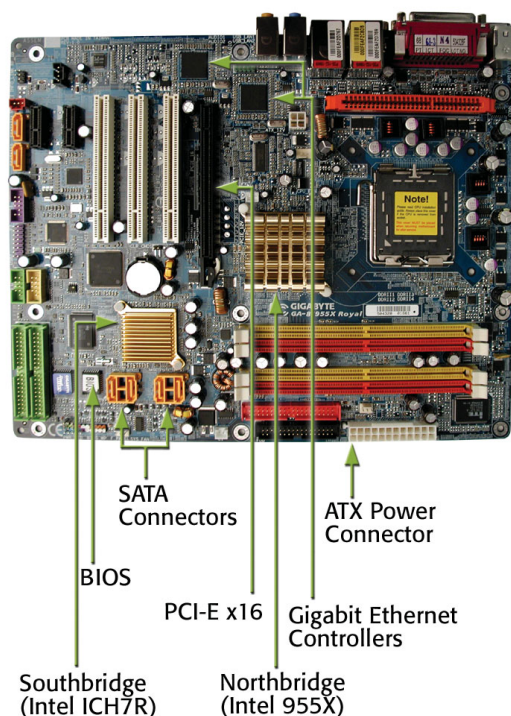
After recording our default scores, we rebooted the test system and pressed DELETE to enter the system's CMOS Setup Utility. Overclocking options are found in the MIT (MB Intelligent Tweaker) section. We set CPU Host

Clock Control to Enabled, giving us access to the CPU Host Frequency (MHz) and PCI Express Frequency (MHz) options. We selected CPU Host Frequency (MHz) and increased the frequency from 266MHz to 280MHz. Doing so increased the FSB from 1,066MHz to 1,120MHz ($280 \times 4 = 1,120$). The CPU's 14X multiplier caused the processor's clock speed to increase to 3.92GHz. In order to make sure we had plenty of room to overclock the memory, we next selected System Memory Multiplier and set it to 2.0 using the PAGE DOWN key. After adjusting the memory frequency, we pressed ESC to return to the main menu and selected Save & Exit Setup.

The increase in FSB didn't change our 3DMark05 score. We reran PCMark04 to see what affect the change in memory frequency might have on the score, but we came away with a 6397 Memory score. The CPU score, however, took a slight dip to 5721. We pressed on, returning to the Setup Utility and increasing the FSB to 290MHz. This time we saw some 3DMark05 movement as our score increased to 3711. In-creasing the FSB another 10MHz resulted in a 3720 3DMark05 score.

At 310MHz we began to run into problems. The system booted fine but spontaneously rebooted while in the middle of a 3DMark05 test. Normally we increase the CPU voltage first, but as we noticed with other boards, our 3.73GHz P4 EE is finicky when it comes to increasing the voltage. We selected CPU Voltage Control and set the voltage at 1.4250V (0.0250V higher than its maximum voltage). Windows refused to load, quickly flashing a blue screen before rebooting. Returning the voltage to Normal, or 1.4000V, allowed Windows to boot, but the system was still unstable with the 310MHz FSB.

We thought that perhaps increasing the PCI-E frequency might stabilize the system, so we set PCI Express Frequency (MHz) to 110MHz. Again, this did nothing to stabilize the system. Increasing the



DIMM, PCI-E, and FSB voltages also failed to stabilize the system.

We left the FSB OverVoltage Control set to 0.10V and the PCI-E OverVoltage Control at 0.10V, returned the DIMM OverVoltage Control to Normal, and reduced the FSB to a less aggressive 305MHz. 3DMark05, however, crashed during one of its initial tests, so we further reduced the FSB to 302MHz. This time around we got a 3DMark05 score of 3733. In-creasing the FSB to 303MHz resulted in a 4.22GHz processor clock speed and yielded a 3742 3DMark05

Overclock Comparison 3DMark05

ASUS P5ND2-SLI Deluxe

Stock Performance	3686
Overclocked Performance	3721

ABIT AA8XE

Stock Performance	3650
Overclocked Performance	3699

★ Gigabyte GA-8I955X Royal

Stock Performance	3689
Overclocked Performance	3742

score. At 304MHz the system became unstable, and without the ability to increase the CPU voltage, there wasn't much we could do to stabilize it. We dropped back to 303MHz and ran PCMark04 and our games.

Our PCMark04 scores were not particularly impressive. Our overall score increased just 226 points to 6116, most likely due to a decrease in our CPU score of 172 points to 5582. Our Memory score was still great at 6898, but we saw little change in our Graphics and HDD scores (4456 and 4548, respectively). Doom 3 frame rates increased slightly to 40.2fps, and Half-Life 2 frame rates increased to 51.36fps.

Final Word

All three boards allowed us to increase the clock speed of our 3.73GHz P4 EE CPU to about 4.20GHz. At 4.22GHz, however, the Gigabyte GA-8I955X yielded the highest clock speed of the three (although just barely). Despite its slight advantage in clock speed, however, the board posted some disappointing PCMark04 numbers. And although game performance was also disappointing, the board did manage to post the best 3DMark05 score for the 3.73GHz P4 EE.

Again, the Pentium 4 640 we examined earlier is a viable alternative to the expensive 3.73GHz P4 EE. Despite only running at 3.2GHz, the P4 640's default 3DMark05 scores were relatively close to those posted by the 3.73GHz P4 EE and some of the overclocked scores are better than those of the 3.73GHz P4 EE. The P4 640 also has more headroom for overclocking. We managed to overclock that processor as high as 4.36GHz. Again, this isn't very surprising, considering that the primary difference between the two processors is the FSB speed they run at. As we saw when we compared the 3.4GHz P4 EE (which runs on an 800MHz FSB) to the 3.46GHz P4 EE (which runs on a 1,066MHz FSB), the 1,066MHz FSB adds little in the way of substantial performance benefits. **CPU**

by Chad Denton

AMD Athlon 64 3800+ & Soltek SL-K890Pro-939

Last time we did a *PC Modder* issue, we overclocked a slew of socket A and socket 754 motherboards with both 64-bit and non-64-bit AMD processors. For this round, we decided to dump the kiddie stuff and focus on AMD's socket 939 CPUs. First up, the Athlon 64 3800+, which is built on the Venice core and features a 2.4GHz clock speed and 512KB of L2 cache, along with the ability to juggle both 32-bit and 64-bit apps. The Venice core, sometimes referred to as Rev. E, has a few new tricks up its sleeve, such as support for SSE3 instructions, improved memory mapping, and better memory loading. The 3800+'s first outing fell into the capable hands of Soltek.

Motherboard

AGP was one technology that bit the dust since the last time we did our Case Studies. All of the AMD-compatible chipsets are also PCI-Express-capable, and the SL-K890Pro-939 is no exception. This motherboard sports VIA's new K8T890 chipset for Athlon 64 and FX processors and, at \$99, Soltek's board is reasonable. Soltek threw in rounded IDE cables, a rear

controlled SATA ports are black, while the Promise SATA ports are orange.

The motherboard's four 184-pin DDR DIMM Sockets (DIMM 1 and 2 are purple, while DIMM 3 and 4 are yellow) are capable of holding a maximum of 4GB of unregistered non-ECC DDR400 memory. The board also supports dual-channel configurations. VIA's VT8237 and Promise's PDC20579 controllers support up to six ATA 133Mbps devices from the three IDE ports, and four SATA drives in RAID 0, 1, and 0+1 configurations. The graphics bus connects to a PCI-E x16 slot just below the northbridge chip, labeled PCI-E1. PCI-E slots 2 through 4 are each x1 slots. Soltek also includes two legacy PCI slots for older peripherals.

The motherboard's rear panel features the usual PS/2 mouse and keyboard ports, a legacy serial port, SPDIF in and out ports, and six audio jacks that work with Realtek's 8-channel AC'97-compliant audio controller. The rear panel also features four USB 2.0 ports and one FireWire 400 port. If you want more, onboard headers will accommodate up to four additional USB 2.0 ports and one more FireWire 400 port.

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3800+
Motherboard	Soltek SL-K890Pro-939
BIOS	
Manufacturer	Phoenix Award
BIOS Version	Version T1.3
Chipset Driver	VIA Hyperion 4.55
RAM	
	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200
Common Components	
Video	
	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake Pipe101
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	BenQ 4X DVD+RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Lian Li PC-7B

the latest version, T1.3, which adds E4 stepping and subsequently SSE3 support for Opteron processors. This BIOS version also includes the fixes addressed in previous BIOS revisions, including keyboard incompatibility issues and DIMM voltage problems.

One thing curiously missing from the list of fixed problems is support for Soltek's Windows-based overclocking utility, RedStorm2. The SL-K890Pro-939's packaging prominently advertises RedStorm2's manual and automatic overclocking features, but when we attempted to run the program, we got an error mes-

AMD Athlon 64 3800+ & Soltek SL-K890Pro-939

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.4GHz	200MHz	12	1.4	4707	4532	5302	4631	4615	3431	39fps	47.72fps
Overclocked Performance	2.62GHz	218MHz	12	1.55	5533	4961	5955	4667	4729	3512	42.2fps	48.59fps

panel USB module, and a bundled software package that includes PC-Cillin 2004, VirtualDrive 7, and RestoreIT! 3 Lite.

The SL-K890Pro-939's appearance is pleasing to the eye, with purple and yellow ports and slots complementing the board's black PCB. The PCI-E slots, CPU socket, and DIMM clips are all beige, while the northbridge chip sports a silver aluminum heatsink. The VIA-

The lone LAN port delivers Gigabit Ethernet networking. Other useful features include the onboard debug LED and a dual-channel diagram etched onto the PCB so you can install your DIMMs without having to consult the manual.

Performance

Once our system was up and running, we flashed the Phoenix Award BIOS to

sage saying the utility doesn't support our motherboard. We have yet to find a Windows-based overclocking utility that tops even an average BIOS for overclocking capabilities, so the lack of RedStorm2 support isn't a huge drawback.

Before we touched the BIOS settings, we ran our benchmarks to establish a baseline. The Soltek board scored 3431 in 3DMark05, which put it in second place

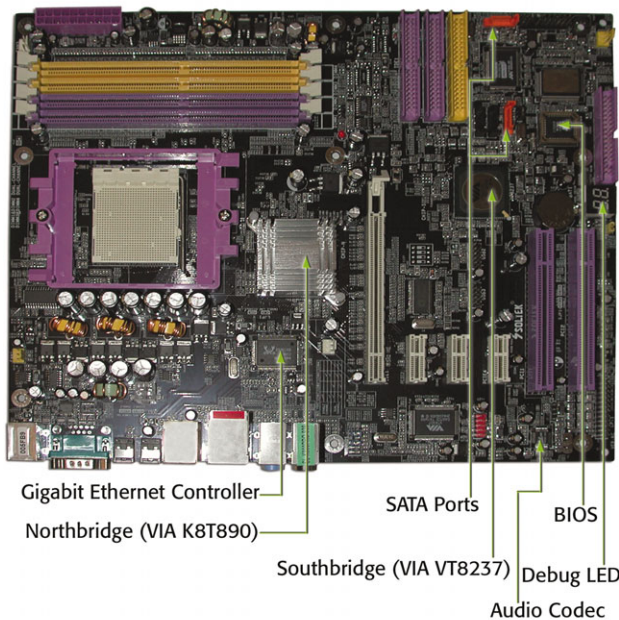
when judged against the two other motherboards we tested with the Athlon 64 3800+. Soltek's baseline 3DMark05 score placed fourth when we compared it against the rest of the motherboards with non-FX processors. This board was an average performer in PCMark04, as well, scoring a 4707 in the overall system test. The SL-K890Pro-939's high point was a 4631 PCMark04 Graphics score, which beat the DFI and Tul Graphics baselines by 210 and 285 points, respectively. Only the ABIT AX8 did better in the Graphics category.

Under the CMOS Setup Utility's Advanced Chipset Features menu item, we found a Performance [sic] Mode option with Normal, Fast, and Ultra options. Fast mode clocks the FSB to 201MHz, while Ultra boosts the FSB to—gasp—203MHz. We ran the tests at these settings, but the improvements were laughable.

We got back into the CMOS Setup Utility by pressing DELETE during the POST. From the main menu, we highlighted the CPU Ratio/Voltage Control menu option and pressed ENTER to access the CPU ratio, voltage, and clock speed, as well as the DIMM voltage and Async PCIEX Clock controls. We changed the CPU Clock from 200MHz to 210MHz and then pressed F10 to save our settings and reboot.

Back in Windows, our system posted a 3477 in 3DMark05. Next we tried a 220MHz CPU Clock, but Windows wouldn't load. Fearing that we had already maxed out the SL-K890Pro-939, we dropped the CPU Clock back to 215MHz and tried to run 3DMark05 again. With the processor clocked to 2.58GHz, our system posted a 3445 in 3DMark05, which was 32 points lower than the previous score. We decided it was time to adjust our voltages.

Back in the CMOS Setup Utility, we upped the CPU VCore Select from 1.4V to 1.5V. Again at 215MHz, the board posted a 3480 in 3DMark05. We upped the CPU



Clock by 1MHz to 216MHz, which yielded another decent gain in 3DMark05 (3499). We raised the vcore voltage a few more times in an attempt to break the 3500 ceiling in 3DMark05, but that didn't work. Any vcore setting below 1.5V wouldn't load Windows, but anything above that left our system unstable, even on the rare occasion that Windows loaded.

At 217MHz and 218MHz, the system wouldn't boot properly, or it would reboot during 3DMark05's game tests. In an attempt to remedy this, we entered the CMOS Setup Utility, pressed ENTER on

LDT & PCI Bus Control, and then changed the LDT Bus Frequency to 1GHz. LDT stands for Lightning Data Transport, which is AMD's HyperTransport bus.

At this point Windows continually rebooted until we shut the system down and cleared the CMOS. We were concerned Windows had been damaged, so we ran 3DMark05 at the default settings. To our astonishment the board posted a 2833, which was 598 points lower than our baseline. Hoping the discrepancy was a fluke, we reset the CPU Clock to 215MHz and raised the vcore voltage to 1.5V and reran 3DMark05. Much to our

relief, the system scored a 3482, which was two points higher than the last time we ran this configuration.

Our last resort was to adjust the memory timings and voltages. First we set the CAS# Latency from 2.5 to 2 (our Corsair XMS memory's native setting). We also set the CPU Clock to 218MHz. 3DMark05 failed to complete, so we raised the DIMM voltage from 2.55V to 2.65V. This got us a 3512 in 3DMark05. We adjusted the CPU Clock a few more times, going as high as 220MHz, but after each adjustment Windows either became unstable or scores went down. The Soltek configuration maxed out at 218MHz (2.62GHz) but racked up some solid gains. The system achieved a 5533 in PCMark04's Overall category, which was the highest among the non-FX AMD processors. Soltek also took the crown in Doom3, delivering 42.2 frames per second.

Final Word

Soltek's SL-K890Pro-939 was a decent overclocker, but we would've liked to see more out of the CPU clock. We suspect that something as simple as a BIOS revision could remedy this problem, in which case, the SL-K890Pro-939 could be one dominating motherboard. **CPU**

by Andrew Leibman

Overclock Comparison 3DMark05

★ Soltek SL-K890Pro-939

Stock Performance	3431
Overclocked Performance	3512

DFI LANPARTY nF4 SLI-DR

Stock Performance	3620
Overclocked Performance	3667

Tul AX480A-GF

Stock Performance	3388
Overclocked Performance	3472

AMD Athlon 64 3800+ & DFI LANParty nF4 SLI-DR

After testing out the Soltek, we put our Athlon 64 3800+ into an NVIDIA nForce4 SLI (Scalable Link Interface) board. More than a few systems builders have opted for the flashy LANParty nF4 SLI-DR as the foundation of their gaming rigs, and we soon found out why. This motherboard is more than the sum of its UV-reactive parts.

Motherboard

The LANParty nF4 SLI-DR motherboard sports NVIDIA's hot nForce4 SLI chipset for socket 939 Athlon 64 and FX processors. This board comes with a ton of extras, including the PC Transpo case harness for lugging your tower from LAN party to LAN party, rounded UV-reactive IDE and floppy cables, and the FrontX 5.25-inch modular drive bay. That extra PCI-E slot and the usual LANParty trappings come at a premium, though; we dropped a cool \$204 for this board, not counting shipping.

DFI adorned the motherboard's black PCB with loads of UV-reactive plastic. The four PCI-E and two PCI slots are yellow, as

chipset also supports four 3Gbps SATA ports and RAID 0, 1, and 0+1 arrays spanning across SATA and PATA devices. A Silicon Image controller manages another four 1.5Gbps SATA ports for RAID 0, 1, 0+1, and 5, offering more storage options than you'll know what to do with.

Along with the two PCI-E x16 slots, DFI threw in one PCI-E x1 slot, a PCI-E x4 slot, and two legacy PCI slots. This board features six USB 2.0 ports and headers for an additional four. DFI didn't forget FireWire either, supplying one 400Mbps port on the rear panel and a header for another 400Mbps port. Onboard Marvell and Vitesse controllers deliver dual Gigabit Ethernet capabilities, while the 8-channel audio comes courtesy of a Karajan audio module, which plugs into a special AUD1 port near the rear panel. The onboard EZ Touch power and reset switches are another unique feature that system builders and power users will appreciate.

Performance

Even before overclocking, our newly assembled system kept running into blue

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3800+
Motherboard	DFI LANPARTY nF4 SLI-DR
BIOS	
Manufacturer	Phoenix Award
BIOS Version	Version LPNF450310
Chipset Driver	NVIDIA chipset driver version 6.53
RAM	
	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200
Common Components	
Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake Pipe101
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	BenQ 4X DVD+RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Lian Li PC-7B

single-channel configuration would yield, we dove into the CMOS Setup Utility looking for a setting that would allow us to use dual-channel memory. After dozens of trial-and-error adjustments, we found that the DRAM Drive Strength (set to Auto by default) would only let us use dual-channel memory if set to Level 4.

With our system finally working, we ran the benchmarks to determine this configuration's baseline. The nF4 SLI-DR posted a 3620 in 3DMark05, which was even higher than the Soltek SL-K890Pro-939's overclocked 3DMark05

AMD Athlon 64 3800+ & DFI LANPARTY nF4 SLI-DR

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.4GHz	200MHz	12	1.38	4847	4847	5475	4421	4791	3620	39.9fps	51.39fps
Overclocked Performance	2.8GHz	233MHz	12	1.67	5390	5233	6268	4432	4784	3667	40.3fps	51.65fps

are the IDE, floppy, and SATA ports. The CMOS battery housing, heatsink mounting frame, and DIMM slots 1 and 3 are also yellow, while DFI chose to set off DIMM slots 2 and 4 with orange plastic.

The nF4 SLI-DR's four DIMM slots support a maximum of 4GB of DDR400 SDRAM. The nForce4 chip lets you attach up to four UltraDMA 133Mbps drives to the two onboard IDE connectors. The

screen errors at startup. After troubleshooting the rest of our hardware, it came down to memory. Only after we started with the memory modules in DIMMs 1 and 2 (single-channel configuration) did we get into Windows. We updated the Phoenix Award BIOS to the latest version, dated 03/10/05, but the updated BIOS didn't solve our problems. Not satisfied with the lower scores that a

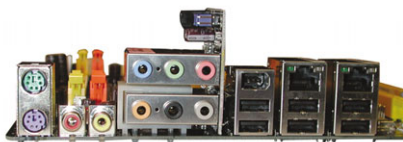
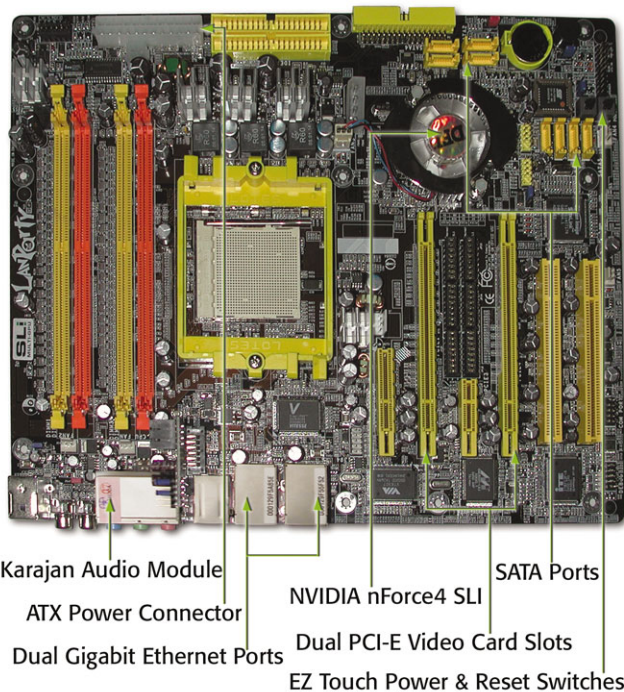
score of 3512. Impressed, we ran PCMark04 hoping for similarly solid scores. Sure enough, this configuration posted a dominating 4847 in PCMark04's Overall category. Other notable PCMark04 scores include a 4847 CPU score and a 4791 HDD score, which were the highest baselines in those categories for non-FX AMD processors. DFI's board also dominated the game tests, posting

the best Doom 3 score at 39.9fps, and the best Half-Life 2 score at 51.39fps.

We restarted our system and entered the CMOS Setup Utility by pressing DELETE. DFI put the overclocking options in the Genie BIOS Settings Menu, accessible from the CMOS Setup Utility's main menu. We pressed ENTER with the Genie BIOS Settings option highlighted and found a multitude of adjustable voltage and clock settings.

This board showed so well at the default settings that we confidently adjusted the FSB Frequency option from 200MHz to 215MHz, which increased our Athlon 64 3800+'s clock speed from 2.4GHz to 2.58GHz. We kept the CPU Core Voltage set to Auto, which was 1.38V, and pressed F10 to save and restart. We ran 3DMark05 and landed a 3641, which was 21 points better than the baseline. Hungry for more, we jumped back into the BIOS and upped the FSB Frequency to 220MHz. Back in Windows, 3DMark05 stalled during the CPU test. We suspected a voltage boost might remedy the problem, so we went back to the CMOS Setup Utility and raised the Core Voltage to 1.45V, keeping the FSB at 220MHz. This time we managed to finish 3DMark05 with a score of 3651.

So far Windows stability was not a problem, so we decided to shoot for 230MHz, but we knew we needed more juice. The CMOS Setup Utility's CPU Voltage item maxed out at a lame 1.55V, which wasn't enough to get us into Windows with the FSB at 230MHz. We scoured the menus and discovered that we could increase the core voltage by percentages using the CPU VID Special Control. We set the core voltage to 1.55V and changed the CPU VID Special Control setting from Auto to 110%, which gave us a 1.67V CPU voltage. Worried that our CPU might be running a bit hot, we set the CPU Shutdown Temperature to 65 degrees Celsius/149 degrees Fahrenheit.



Satisfied that we had the power we needed, we set about trying to eliminate any memory bottlenecks. We changed the DRAM Voltage Control from 2.6V to 2.7V, the CAS Latency Control from Auto to 2.0 (our Corsair XMS memory's native setting), and changed LDT/FSB Frequency Ratio to X 3 (from Auto). (LDT stands for Lightning Data Transport and is the former name of AMD's HyperTransport bus technology.) Although our system was stable enough to post scores, it only yielded a

Overclock Comparison 3DMark05

Soltek SL-K890Pro-939

Stock Performance	3431
Overclocked Performance	3512

★ DFI LANPARTY nF4 SLI-DR

Stock Performance	3620
Overclocked Performance	3667

Tul AX480A-GF

Stock Performance	3388
Overclocked Performance	3472

3637 in 3DMark05. PCMark-04 was showing more promise, with a 5364 Overall score.

Because our graphics score slipped 13 points from 4421 to 4408, we changed the PCI Express Frequency from 100MHz to 110MHz. We also changed the DRAM Voltage Control from 2.7V to 2.8V, adjusted the LDT/FSB Frequency Ratio to X 5, changed LDT Voltage Control from the default 1.2V to 1.3V, and upped the Chipset Voltage Control from 1.5V to 1.7V.

After the aforementioned adjustments and some more FSB tweaking, we managed to get the FSB Frequency up to 233MHz, which gave us a clock speed of 2.8GHz. Having found a stable system with our

various PCI-E, FSB, DRAM, and LDT frequencies and voltages, we ran the complete battery of tests to see just where we stood. DFI's LANParty nF4 SLI-DR scored a 3667 in 3DMark05, which was second overall among the non-FX AMD processors. The configuration also managed a 5390 in PCMark04, consisting of a 5233 CPU score, 6268 Memory score, 4432 Graphics score, and 4784 HDD score. The CPU, Memory, and HDD scores all turned out to be the best overclocked scores of the group for non-FX AMD processors. The game benchmarks were less impressive, only gaining 0.4fps in Doom 3, delivering 40.3fps, and 0.26fps in Half-Life 2, for an overclocked fps rate of 51.65.

Final Word

Having tweaked and tuned the LANParty nF4 SLI-DR, we can confidently recommend this board to anyone with or without overclocking ambitions. The LANParty nF4 SLI-DR's baseline scored outperformed the overclocked Tul AX480A-GF in six of eight tests. Although the nF4 SLI-DR costs a pretty chunk of change, its overclockability alone makes it worth every penny. **CPU**

by Andrew Leibman

AMD Athlon 64 3800+ & Tul AX480A-GF

The Tul AX480A-GF was the third and final motherboard in line for the Athlon 64 3800+, and this one was a doozy. When overclocking multiple motherboards on a single processor, we find it's best to use the same drivers whenever possible. This is one situation when driver uniformity wasn't possible, at least not at first. We like to call the AX480A-GF the little motherboard that could.

Motherboard

Tul's AX480A-GF motherboard is built around ATI's Radeon Xpress 200P chipset, also known as the RX480, for socket 939 Athlon 64 processors. This chipset favors discrete PCI-Express graphics, unlike its sister, the Radeon Xpress 200 (RS480), which features an integrated X300-based GPU. This motherboard is one of the cheaper PCI-Express motherboards out there, ringing in at \$92 before shipping.

Tul's subdued color scheme consists of a red PCB with beige and black PCI and PCI-E slots. The memory slots are black and blue. The two IDE ports are blue and white, while the floppy port is black. The

drives, while the onboard SATA ports let you connect up to four 1.5Gbps hard drives. ATI's SB400 Southbridge chip offers RAID 0 and RAID 1 configurations.

Tul situated ATI's lone x16 graphics pipeline just below the northbridge chip. Three PCI-E x1 slots deliver up to 5Gbps of throughput for your peripherals. Tul installed two regular PCI slots just above the CMOS battery. The rear panel has four USB 2.0 ports and internal headers let you connect an additional four ports. Tul included FireWire as well, with one 400Mbps port on the rear panel and another optional 400Mbps port via internal headers. Realtek's RTL8110S chip provides this board with Gigabit Ethernet LAN capabilities. The six audio jacks on the rear panel route 8-channel sound to your speakers with the help of the integrated Realtek ALC850 chip.

Performance

Installing Windows on this board was a bit of a chore. We discovered early on that the SATA ports had to be enabled from within the BIOS Setup Utility. If a

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3800+
Motherboard	TUL AX480A-GF
BIOS	
Manufacturer	American Megatrends
BIOS Version	AX480A-940330-1
Chipset Driver	ATI Catalyst 5.6
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200
Common Components	
Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake Pipe101
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	BenQ 4X DVD+RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Lian Li PC-7B

new BIOS didn't resolve the disabled SATA ports problem.

After we installed the latest GeForce 6600GT video driver (version 71.89), the system displayed a BSOD and a MACHINE_CHECK_EXCEPTION error, which recommended that we remove the last piece of hardware we had installed. We used Safe Mode to remove the video driver and then tried installing successively older drivers until we found one that worked. We finally got version 66.32 to work, but the driver was so out of date that our system stumbled over 3DMark05 like it was using integrated graphics. The

AMD Athlon 64 3800+ & Tul AX480A-GF

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.4GHz	200MHz	12	1.45	4505	4439	3507	4346	4277	3388	38.7fps	47.07fps
Overclocked Performance	2.82GHz	235MHz	12	1.75	5136	5182	4017	4349	4287	3472	37.9fps	47.44fps

four SATA ports, heatsink mounting frame, and onboard speaker are all black. A silver aluminum northbridge heatsink, bearing the Radeon Xpress logo, lies between the 939-pin CPU socket and the PCI-Express graphics card slot.

The AX480A-GF's four DIMM slots can handle up to 4GB of DDR400 SDRAM. The two IDE ports support as many as four UltraDMA 133Mbps hard

manufacturer insists on disabling the SATA ports by default, we prefer to have a jumper on the motherboard for this. As it was, every time we cleared the CMOS we had to re-enter the BIOS Setup Utility and enable the SATA ports just to get back into Windows. We installed Windows and then flashed the American Megatrends BIOS to the latest version, 940202. Unfortunately, the

AX480A-GF scored a 2515, which was 916 points lower than the Soltek SL-K890Pro-939's lame 3431 3DMark05 score. Because PCMark04 puts less emphasis on the graphics side, the Overall score was a much more palatable 4537.

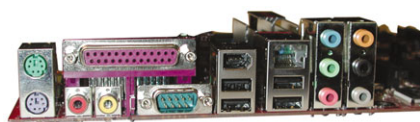
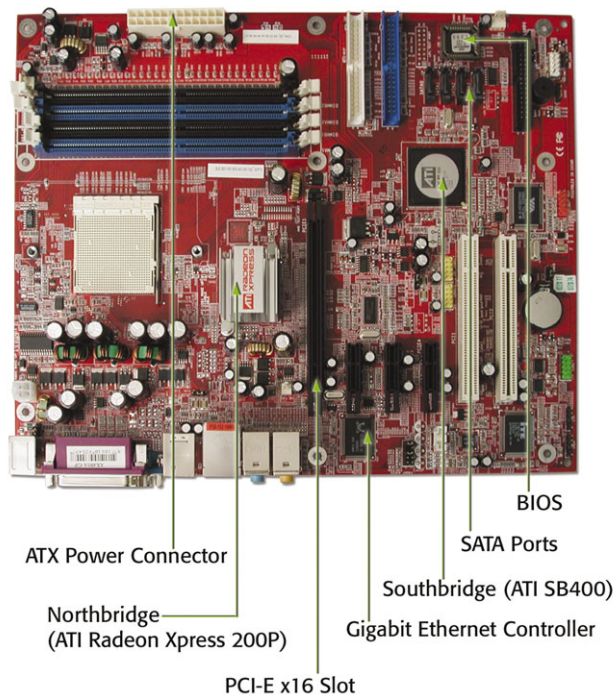
Desperate for a better 3DMark05 score, we emailed Tul's technical support and asked for help. In the meantime we started adjusting the CPU/HT Clock and

VCore voltages from the BIOS Setup Utility. Not long after we started overclocking, Tul's technical support guru sent us a ray of hope in the form of a new BIOS. We flashed the new BIOS (version 940330-1) and then rebooted. We installed the GeForce 6600GT video driver version 71.89, crossed our fingers, knocked on wood, rubbed Buddha's belly, and then restarted our system. 3DMark05 posted 3388, which was still low but not unreasonably so. PCMark04's Overall score dipped a bit to 4505.

With our baseline scores in hand, we dove into the new BIOS Setup Utility, picked up where we left off, and upped the CPU/HT Clock from 200MHz to 218MHz. Because this board features a 2000MTps (megatransfers per second) two-way HyperTransport bus, we changed the CPU: RX480-NB HT Link Speed from 800MHz to 1GHz. Our last stable setting from our overclocking with the previous BIOS was 218MHz, but this time the adjustment yielded a healthy 3431 in 3DMark05.

Next, we tried 220MHz, but 3DMark05 wouldn't finish, so we tried again after changing the Processor Voltage setting from 1.45v to 1.55v. Again 3DMark05 failed. Upping the CPU voltage to 1.6V didn't help, so we raised the DIMM Voltage Control from 2.5V to 2.7V and gave the CPU another .05V increase. We also changed the CAS Latency of our DRAM from 2.5 to 2. This time we finally got a score, albeit a lower one at 3423.

Worried that the system might be taxing our voltages a bit, we raised the CPU VCore another 0.1V to 1.75V. We also throttled the CPU/HT Clock another 5MHz to 225MHz, which gave us a 2.7GHz effective clock speed. Back in Windows, we ran 3DMark05, which reported back a 3448. We were pleased to see that the latest adjustments brought up our 3DMark05 score. This board was showing no signs of slowing down, so we



dove back into the BIOS Setup Utility and tacked another 5MHz onto our CPU/HT Clock. At 230MHz, the system posted a 3452 in 3DMark05. We got a 3472 in 3DMark05 when we adjusted the CPU/HT Clock to 235MHz.

Next we tried to push our luck and raised the CPU/HT Clock to 245MHz, but Windows refused to load. We took our rig down a notch to 240MHz, but still Windows wouldn't load. Mindful of the fact that we were increasing the processor's

heat output as we increased the CPU voltage, we risked another 0.05V to bring our CPU VCore up to 1.8V. At 240MHz, we managed to get back into Windows, but 3DMark05 failed to finish. We dared to add another 0.05v to the CPU VCore and try again, but to no avail; 3DMark05 still failed. We continued to step back by 1MHz increments, but we only managed to get a 3450 from 3DMark05 when the CPU/HT Clock was set at 236MHz. We also toyed with the PCI-E Clock, setting it as high as 110MHz (from the 100MHz default setting), but none of the settings we tried got our 3DMark05 score above 3463.

At this point we felt we had maxed out the voltages and feared anything more might burn a processor-shaped hole through our case. Although we managed to overclock the Athlon 64 3800+ to 236MHz, it performed better at 235MHz (2.82GHz), so we went with the lower CPU/HT Clock for our final results. PCMark04's Overall rating stood at 5136, the second lowest of the non-FX motherboard tests. The AX480A-GF finished in last place in PCMark04's Memory (4017) and Graphics (4349) tests. Tul's CPU rating of 5182 was the one decent score, finishing in second place, just 51 points shy of the top-performing DFI.

Final Word

It's perplexing that Tul's "next-gen" PCI-Express motherboard didn't come with the SATA ports enabled by default. No big deal. However, the AX480A-GF's inability to handle our video card's latest drivers was a big deal. As we went to press, Tul's Web site only offered the GeForce-intolerant 940202 BIOS, but hopefully by the time you read this the updated BIOS will be available. Until ATI and NVIDIA can get along on the same motherboard, we recommend avoiding the AX480A-GF despite its healthy FSB overclockability. **CPU**

by Andrew Leibman

Overclock Comparison 3DMark05

Soltek SL-K890Pro-939

Stock Performance	3431
Overclocked Performance	3512

DFI LANPARTY nF4 SLI-DR

Stock Performance	3620
Overclocked Performance	3667

★ Tul AX480A-GF

Stock Performance	3388
Overclocked Performance	3472

AMD Athlon 64 4000+ & ABIT AX8

We chose the Athlon 64 4000+ for the last of our non-FX AMD processors, which shares the 2.4GHz clock speed, 64-bit computing, and 128-bit memory controller with its 3800+ brother. The 4000+ features an expanded 1MB L2 cache slapped onto the aging ClawHammer core, which lacks some of the Venice core's benefits, such as the added SSE3 instructions and the improved memory mapping and loading. The ABIT AX8 is first in line to take a spin with our fresh CPU.

Motherboard

The ABIT AX8 motherboard is built on the VIA K8T890 chipset, which is designed for AMD's Athlon 64 and FX processors. ABIT has a lot of experience building enthusiast motherboards, so we were anxious to see what this PCI Express-compatible board could do. And we plunked down a very reasonable \$98 for the opportunity.

The blue-and-purple 184-pin DIMM slots can deliver dual-channel performance with up to 4GB of DDR400 SDRAM.

VT6421 gives you the best of both worlds with RAID 0+1.

The lone x16 PCI-E slot supports up to 8Gbps of graphics bandwidth, while three more PCI-E x1 slots provide 5Gbps of I/O bandwidth. Two plain PCI slots should keep you from throwing away your favorite legacy peripherals, at least for now.

ABIT installed an IC Plus IP1000A controller near the rear panel risers for Gigabit Ethernet networking. On the rear panel you'll find four USB 2.0 ports, a FireWire 400 port, optical digital audio in and out ports, five audio jacks for 5.1 surround sound, and PS/2 mouse and keyboard ports. ABIT also included serial and parallel ports. Internal headers allow for four more USB ports and one more FireWire 400 port. Systems builders and enthusiasts will appreciate the onboard debug LED.

Performance

After installing Windows, we downloaded the latest BIOS, Phoenix Award version 11, and flashed it from a bootable floppy disk. ABIT's Web site provides detailed information about the issues that

System Specs

Processor, Motherboard & Drivers

Processor	AMD Athlon 64 4000+
Motherboard	ABIT AX8
BIOS	
Manufacturer	Phoenix Award
BIOS Version	Version 11
Chipset Driver	VIA Hyperion 4.55
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200

Common Components

Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake Pipe101
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	BenQ 4X DVD+RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Lian Li PC-7B

Surprisingly, the FSB was already over-clocked to 204MHz (from 200MHz). ABIT's AX8 may provide users with some extra out-of-the-box performance, but we needed our baselines to be the same across the board. We restarted the system, pressed DELETE to access the CMOS Setup Utility, and changed the CPU Operating Speed from Auto to User Define. We changed the External Clock to 200MHz.

The AX8 scored a 3434 in 3DMark05, which was third among our non-FX CPUs. ABIT's board scored a 4755 in PCMark04's Overall test, which was just 92 points below the top-ranked DFI

AMD Athlon 64 4000+ & ABIT AX8

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.4GHz	200MHz	12	1.5	4755	4534	5580	4644	4591	3434	39.2fps	48.1fps
Overclocked Performance	2.64GHz	220MHz	12	1.65	5201	5012	6126	4672	4616	3502	39.6fps	48.74fps

The VIA K8T890 northbridge also supports AMD's high-end 2GHz HyperTransport bus. VIA's VT8237 Southbridge supports up to six UltraDMA 133Mbps devices from the three onboard IDE ports. VIA's Southbridge and the VIA VT6421 controller manage two SATA channels each for up to four 150MBps hard drives. Each SATA controller also lets you implement RAID 0 and RAID 1 arrays, while the

each revision addresses and the BIOS' compile date. The new BIOS added support for AMD processors that feature the Venice core, fixed a problem with USB mice not working in DOS, and updated VIA's SATA RAID to version 1.20.

After installing the latest drivers, we used CPU-Z, an application that displays the CPU's core, clock speed, and current FSB, to examine our default settings.

LANParty nF4 SLI-DR's Overall score. The AX8 also posted a 4534 CPU score and a 4591 HDD score. ABIT managed to snag the top spots in the Memory and Graphics categories, with a 5580 and a 4644, respectively. The AX8 achieved 39.2fps when running Doom 3, while Half-Life 2 sped along at 48.1fps.

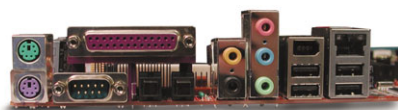
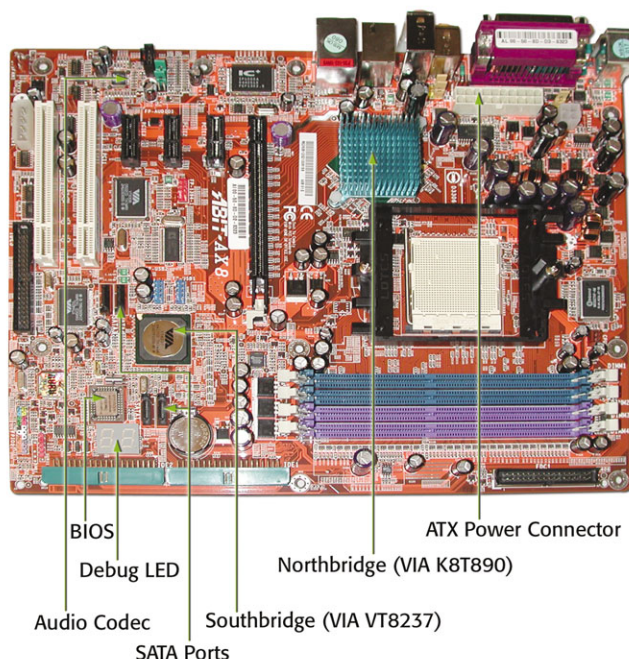
In the CMOS Setup Utility, we pressed ENTER on the uGuru option, raised the

External Clock from 200MHz to 215MHz, and then pressed F10 to save the changes and restart our system. Back in Windows, we started 3DMark05, but the test didn't finish. We suspected a gentle power boost might stabilize the system, so we went back into the CMOS Setup Utility and increased the CPU Core Voltage from 1.5V to 1.6V. This time 3DMark05 finished with a 3477, a decent increase.

In the CMOS Setup Utility again, we highlighted Advanced Chipset Features and pressed ENTER to access the DRAM Configuration menu. We changed the DRAM Timing Selectable from AUTO to By SPD, which lets the motherboard detect and use the memory's default timings and speeds. We didn't change the External Clock or the voltages this time and just ran PCMark04. While the CPU and Overall scores were up, the Memory score dropped to 5230, which was 350 points below the baseline. As a result, we chose to keep our memory at the Auto setting throughout our testing.

This time we drove the External Clock to 220MHz. We also changed the DDR SDRAM Voltage from the default 2.6V to 2.7V because we were worried that our memory might become a stumbling block. Our memory is rated for 2.75V, so we weren't worried about burning up our RAM. In Windows again, the AX8 posted a 3482 in 3DMark05 and a 5206 in PCMark04's Overall category. We were also pleased to see our Memory score surge ahead to 6124.

Next we raised the External Clock to 225MHz and raised the CPU Core Voltage to 1.65V to compensate for the extra power draw. When we attempted to get back to Windows, the system continually rebooted after completing the POST. Worried that we were overtaxing our HyperTransport bus, we adjusted the LDT (Lightning Data Transport), the former name for AMD's HyperTransport bus. In the CMOS Setup Utility again, we pressed ENTER on



Advanced Chipset Features, accessed the LDT & PCI Bus Control menu option, and then changed the LDT Bus Frequency from Auto to FSB x 4, which would give us a 900MHz LDT Bus (225 x 4). We restarted the system but could only get back to Windows by starting in Safe Mode.

Next we tried overclocking the LDT Bus. We went into the CMOS Setup Utility and changed the LDT Bus Frequency from FSB x 4 to FSB x 5, which gave us an 1,125MHz LDT Bus (225 x 5).

Overclock Comparison 3DMark05

★ ABIT AX8

Stock Performance	3434
Overclocked Performance	3502

ASUS A8N-SLI Deluxe

Stock Performance	3535
Overclocked Performance	3761

MSI RS480m2-IL

Stock Performance	3402
Overclocked Performance	3429

Windows started to load this time, but the system displayed the dreaded BSOD and then rebooted. Back in the CMOS Setup Utility we set the LDT Bus back to Auto and then tried raising the CPU Core Voltage in 0.05V increments all the way to 1.75V, but we still couldn't get a stable Windows. We also tried upping the northbridge voltage from the default 1.5V to 1.6V and the HyperTransport voltage from 1.2V to 1.3V, but still no dice.

We began lowering the External Clock. Even with the External Clock set at 221MHz and the CPU Core Voltage at 1.65V, Windows would hang during the loading screen. We adjusted the External Clock back to 220MHz, our highest

stable setting, and then began adjusting the PCI-E Frequency. After a few more tests, we found the PCI-E Frequency gave us the biggest benefit when set to 110MHz, from the default 100MHz. The ABIT AX8 posted a 3502 in 3DMark05 and a 5201 in PCMark04's Overall category. PCMark04's CPU, Memory, and HDD scores were 5012, 6126, and 4616, respectively. The AX8 managed to hold on to the Graphics title with a 4672, narrowly edging out the Soltek's 4667. The overclocked configuration scored 39.6fps in Doom 3 and 48.74fps in Half-Life 2, which were both less than a single frame per second faster than the baseline scores.

Final Word

Despite ABIT's overclocker-friendly uGuru CMOS Setup Utility, this board was a bit of a disappointing performer. Gamers will appreciate the flexibility of the AX8's PCI-E clock, which yielded some good scores for us. The 220MHz External Clock translates to a 2.64GHz clock speed. The ASUS A8N-SLI was also tested with the Athlon 64 4000+ but managed to squeeze a little more from the aging ClawHammer core. **CPU**

by Andrew Leibman

AMD Athlon 64 4000+ & ASUS A8N-SLI Deluxe

ASUS was one of the first manufacturers to offer an SLI (Scalable Link Interface) motherboard back in November, almost two months before DFI's LANParty SLI-DR came out. As a result, ASUS had that much more time to optimize the BIOS and squeeze every bit of performance out of NVIDIA's chipset. Anxious to see what the ASUS A8N-SLI Deluxe could do, we popped in our Athlon 64 4000+ and let 'er rip.

Motherboard

ASUS strapped NVIDIA's nForce4-SLI chipset onto the A8N-SLI Deluxe's black PCB. This socket 939 mobo feels right at home with either FX or non-FX Athlon 64 processors. ASUS packed the A8N-SLI Deluxe's box with so many expansion modules that if you install all of them, plus a non-Ultra GeForce 6 or 7 series graphics card, you'll have one expansion slot left open on the case's back (assuming you are using a standard ATX midtower case). You better forget about your case's expansion slots if you happen to install two GeForce 6800 Ultra cards, which occupy four slots.

Four black and blue DIMM slots manage a maximum of 4GB of DDR400 SDRAM in dual- or single-channel configurations.

The A8N-SLI's two blue and black x16 PCI-E slots (x8 when in dual video card mode) are separated by two PCI-E x1 slots and the ASUS EZ Selector. Orienting the EZ Selector card one way disables the secondary PCI-E x16 slot, while the opposite orientation enables both slots.

The board also includes three normal PCI slots. The rear panel features four USB 2.0 ports and one FireWire 400 port. Onboard headers let you connect an additional six USB 2.0 ports and another FireWire 400 port. Dual Gigabit LAN comes courtesy of two controllers, NVIDIA's nForce4 Gigabit MAC (Media Access Controller), and Marvell's 88E81001 chip. The onboard Realtek ALC850 codec supports 8-channel audio through the six rear-panel jacks and the coaxial and optical SPDIF ports.

Performance

After having successfully set up our system, we flashed the BIOS to the latest

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 4000+
Motherboard	ASUS A8N-SLI Deluxe
BIOS	
Manufacturer	Phoenix Award
BIOS Version	Version 1011
Chipset Driver	NVIDIA chipset driver version 6.66
Common Components	
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200
Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake Pipe101
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	BenQ 4X DVD+RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Lian Li PC-7B

utility didn't offer us the same flexibility as the CMOS Setup Utility, so we over-clocked this board using only the BIOS.

Before we even touched our settings, we ran our benchmarks to determine our baseline scores. The A8N-SLI Deluxe achieved a 3535 in 3DMark05, which was just 85 points shy of DFI's top-ranked 3620. The board finished with a 4579 in PCMark04's Overall category and managed a 4413, 4398, and 4707 in PCMark04's CPU, Graphics, and HDD categories, respectively. The A8N-SLI Deluxe's 4659 Memory score was a massive 921 points below the

AMD Athlon 64 4000+ & ASUS A8N-SLI Deluxe

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.4GHz	200MHz	12	Auto	4579	4413	4659	4398	4707	3535	39.7fps	50.84fps
Overclocked Performance	2.74GHz	228MHz	12	1.65	5236	5085	5354	4573	4725	3761	41.9fps	52.61fps

ASUS is serious about storage with this board, offering two SATA controllers for up to eight devices. The Silicon Image controller can handle four 1.5Gbps SATA drives in RAID 0, 1, 0+1 and five arrays. NVIDIA's NVRAID offers 3Gbps throughput in RAID 0, 1, 0+1, and JBOD arrays between both SATA and PATA devices. The two onboard IDE ports support up to four UltraDMA 133 drives.

version ASUS offered on its Web site. The Phoenix Award BIOS version 1011 added support for dual-core CPUs and resolved several problems with the ASUS Update utility and ASUS' AI NOS (Non-delay Overclocking System). You can access the AI NOS overclocking settings from the CMOS Setup Utility or from within Windows using ASUS' AI Booster utility. The Windows-based overclocking

LANParty's 5580. The board fared a little better in the game tests, finishing second only to DFI in both Doom 3 (39.7fps) and Half-Life 2 (50.84fps).

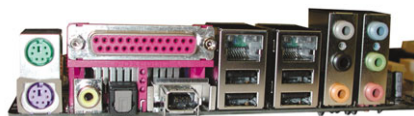
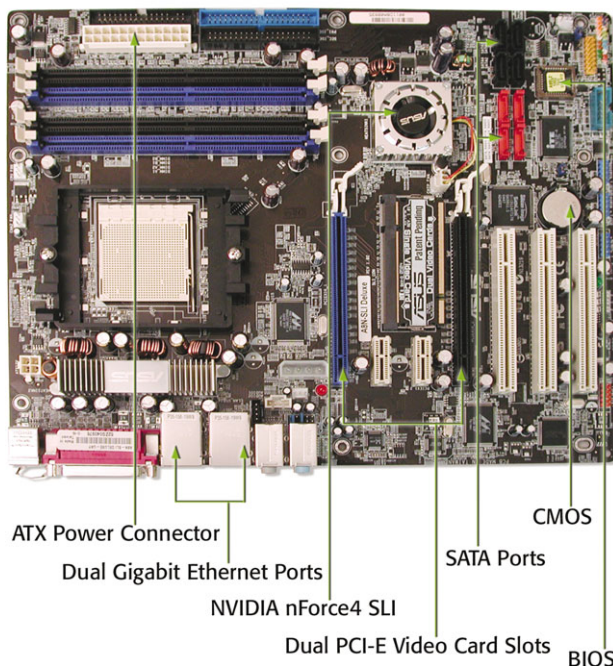
With our mediocre baselines in the bag, we restarted the computer, pressed DELETE to enter the CMOS Setup Utility, and then used the arrow keys to display the Advanced tab of the CMOS Setup Utility. The A8N-SLI Deluxe's

Phoenix Award BIOS features several overclocking options within the JumperFree Configuration menu. We selected AI Overclock for the Overclock Profile and then selected Overclock 5% from the Overclock Options, which upped the CPU Frequency to 210MHz. We pressed F10 to save our changes and restarted the computer. 3DMark05 posted a 3604, which was already better than the overclocked 3DMark05 scores for the non-FX ABIT, Tul, Soltek, and MSI motherboards.

Next we tried the 8% and 10% Overclock Options, which gave us 3616 and 3609 3D-Mark scores, respectively. When overclocked at 10% (220MHz), the system's 3D-Mark05 score slipped a bit, so we changed the Overclock Profile to Manual, raised the CPU Frequency another 5MHz to 225MHz, and changed the CPU Voltage from Auto to 1.6V. We also navigated to the DRAM Configuration menu (in CPU Configuration) and raised the DDR Voltage to 2.75V. This time 3DMark05 slipped to 3572.

Hoping to power through our slipping scores, we went back into the CMOS Setup Utility, added 2MHz to the CPU Frequency (227MHz), and raised the CPU Voltage to 1.65V. We also went back to the DRAM Configuration menu and noticed that our DRAM's Memclock Index Value was set to 333MHz. We changed it to 400MHz and, while we were at it, lowered the CAS Latency from 2.5 to 2.0. Back in Windows we achieved a 3610 in 3DMark05, which was better, but only by one point. We ran 3DMark05 again after raising the CPU Frequency to 230MHz, but the A8N-SLI disappointed again, posting a 3598 in 3DMark05.

Because Windows had been stable so far, we didn't even touch the voltages, but instead went into the PEG Link Mode menu (on the Advanced tab) and changed the setting from Auto to Fast. According to a press release from ASUS, PEG Link



Mode lets users adjust GPU and VGA memory throughput. Back in Windows the ASUS board delivered a 3721 in 3DMark05, which was 54 points above the previous best 3DMark05 score, posted by DFI. And we were just getting warmed up. Next we changed the PEG Link Mode from Fast to Faster, which resulted in a 3730 in 3DMark05.

We raised the CPU Frequency to 235MHz and even 240MHz, but each time we got back into Windows, our

scores weren't reflecting much improvement. A quick glance at CPU-Z, an application that displays the clock speed, multiplier, and current FSB, revealed the culprit: The motherboard was forcing the multiplier down to 10X and 8X. Back in the CMOS Setup Utility, we changed the CPU Multiplier to the processor's native 12X. When we tried to reboot at 235MHz, the system buckled under the stress.

When we bumped the CPU Frequency back down to 230MHz and booted the system, we noticed that 3D-Mark05 continually failed, regardless of the settings we adjusted. Because we hadn't immediately noticed the self-adjusting multiplier, we had no

way of knowing whether our previous 3730 score in 3DMark05 had occurred at the full 2.76GHz clock speed. We started stepping back from 230MHz and finally found the sweet spot at 228MHz. The A8N-SLI Deluxe managed a 3761 in 3DMark05, which handily beat DFI's top-ranked 3DMark05 score by almost 100 points. The ASUS board's PCMark04 scores were less impressive at a 5236 Overall score. ASUS managed a 5085 in the CPU category, 5354 for Memory, 4573 for Graphics, and 4725 for the HDD category. Doom 3 improved to the tune of 41.9fps, while Half-Life 2 ran at 52.61fps, which was also the best among the non-FX processors.

Final Word

The ASUS A8N-SLI Deluxe isn't the crazy overclocker that the DFI LANParty SLI-DR is, but it did manage to take the top spots in the Half-Life 2 test and 3DMark05. Enthusiasts will appreciate this board's many adjustable BIOS options, but if you're looking for real-world improvements and not just to overclock the motherboard itself, make sure you manually set the multiplier. **CPU**

by Andrew Leibman

Overclock Comparison 3DMark05

ABIT AX8

Stock Performance	3434
Overclocked Performance	3502

★ ASUS A8N-SLI Deluxe

Stock Performance	3535
Overclocked Performance	3761

MSI RS480m2-IL

Stock Performance	3402
Overclocked Performance	3429

AMD Athlon 64 4000+ & MSI RS480M2

For the last board of the 4000+ set, we used the MSI RS480M2. After getting a surprising 3761 3DMark05 score with the ASUS A8N-SLI Deluxe, we were anxious to see if this micro-ATX board could keep up.

Motherboard

The MSI RS480M2 is one of the flashier boards we saw in our case studies. The red board certainly stands out, and the blue-and-black DDR slots and IDE channels do much to accent this spiffy device. The PCI Express x16 is black with three beige PCI slots below it. The only color aspect of this board that seems slightly out of place is the bright orange that was used for the four SATA ports. The RS480M2 would definitely be a pretty board to view through your case window.

ATI equipped this board with its Radeon Xpress 200 chipset. This chipset has been lauded for its ability to run high-definition graphics and thereby take gaming to a level it has never seen. Though it works well with 32-bit applications,

The RS480M2 can support up to eight USB 2.0 ports and two 1394 ports. This board doesn't have gigabyte LAN capabilities; it only has Realtek's 8100C 10/100 LAN chip.

Realtek provided the standard audio codec for the RS480M2. It uses the ALC658C codec, which is AC97 v2.3 compliant and also meets PC2001 specifications.

There isn't anything incredibly special about the rear panel of this board. It has the basic PS/2 connections for your mouse and keyboard, a parallel port for your printer, and a VGA port for your monitor. You also get the 10/100 LAN port next to four USB ports and an IEEE 1394 port. For your multimedia devices, the panel is equipped with composite TV-Out and SPDIF-Out jacks, with an S-Video port, and the usual Line In/Out and microphone jacks for your audio needs.

Performance

Before you start overclocking, make sure you check out MSI's Web site. It can

System Specs

Processor, Motherboard & Drivers

Processor	AMD Athlon 64 4000+
Motherboard	MSI RS480M2
BIOS	
Manufacturer	Award
BIOS Version	7093 v3.4
Chipset Driver	Catalyst 5.6
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200

Common Components

Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake CL-P0006
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	Optorite DD0405 DVD RW
Floppy	NEC 1.44 MB drive
Power Supply	550W Antec TruePower II-550
Case	Cooler Master Centurion

Drivers Web site. There you can find the Catalyst 5.6 driver.

Even after we collected these updates, we were extremely disappointed in the overclocking options with this board. There are no adjustments for the normal settings, such as FSB; core, memory, or chipset voltages; or memory frequencies, so we had to look for something other than sheer clock speed to boost our performance.

Because those tools were missing, we had to find new settings to adjust. These included the LDT frequency, CAS latency, and PCI Bus. This was actually kind

AMD Athlon 64 4000+ & MSI RS480M2

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.38GHz	199MHz	12	1.5	4760	4488	5574	4439	4212	3402	38.3fps	46.5fps
Overclocked Performance	2.38GHz	199MHz	12	1.5	4666	4438	5488	4424	4195	3429	38.5fps	46.2fps

the Xpress 200 chipset is de-signed to lead computer users into the realm of 64-bit applications.

This MSI board has four slots for 184-pin DDR 333/400 DIMMs and, as we mentioned earlier, four fluorescent-orange SATA ports, a respectable number for a micro-ATX board. It can hold up to 4GB of RAM, which could prove extremely valuable as you continue to upgrade.

be a little confusing, but meander your way to the BIOS downloads. You can find the latest version, 3.4, of the Award BIOS that supports the AMD K8 revision E stepping CPU. You can also grab some new drivers off the site. The Driver Center has files to update system drivers, new Realtek Ethernet drivers, and an audio codec update for you to install. To get the latest chipset driver, hit up ATI's

of nice because we didn't have to worry as much about creating an unstable environment that might jeopardize the information we had on our system.

As we started benchmarking, we noticed that at most settings, including the Optimized Default, the FSB was actually underclocked to 199MHz. So even at the default setting we were actually getting a clock speed of about 2.38GHz, not

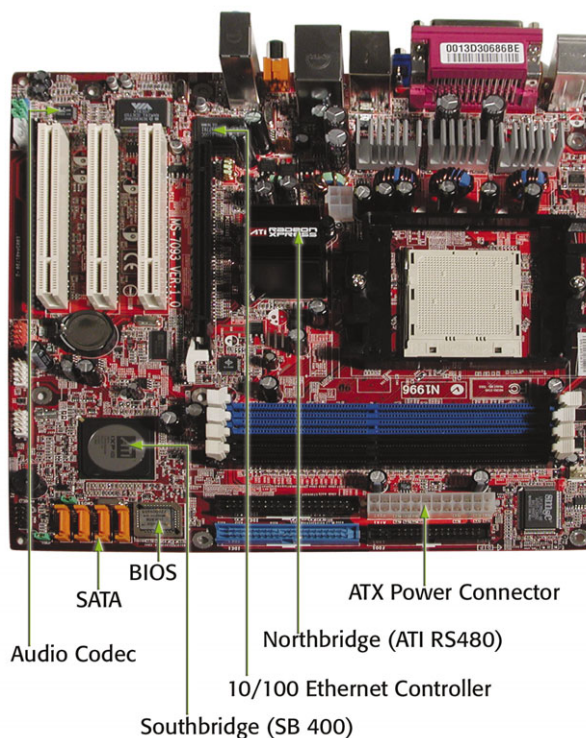
the 2.4GHz the 4000+ is supposed to run at stock.

Our baseline scores weren't awful, but they weren't that great either. We had a 3402 3DMark05 score, a 4760 PCMark04 score, and rates of 38.3fps and 46.5fps on Doom 3 and Half-Life 2, respectively. Except for the stock PCMark04 score, which was the best out of this group of three, the RS480M2 finished last in the rest of our benchmark categories.

Our main strategy to improve scores was to find the best combination for the LDT Frequency and the CAS Latency. We achieved our top 3DMark05 score, 3429, by using all the default settings, except boosting the LDT Frequency from the 800MHz default to 1GHz. Although this raised our 3DMark05 score, it actually lowered our PCMark04 score from 4760 to 4666—nearly 100 points! We also received a 38.5fps Doom 3 result, up 0.2fps from the default. Like our PCMark04 score, our Half-Life 2 score also dropped, from 46.5fps at the default setting to 46.2fps.

We continued to change various values and supports, but we couldn't get our PCMark04 score to come anywhere near the default PCMark04 score. Our top manually adjusted score was 4681. It came when we moved the LDT Frequency to 1GHz and then dropped the CAS Latency from the 2.5 default down to 2. We expected this would make a greater impact on the scores because we were lowering the time it took for information to go to our memory. This wasn't the case, as our 3DMark04 score suffered and our Doom 3 and Half-Life 2 frame rates were lower than they were at the optimized default level.

When compared to the other boards of this group (the Abit AX8 and the ASUS A8N-SLI Deluxe), the MSI RS480M2 finished in a distant third place. Its best 3DMark05 score, 3429,



was more than 70 points behind the second-place finisher of this trio, the Abit AX8, which scored a 3502 at its top stabilized settings. The ASUS A8N-SLI Deluxe scored a 3761 in 3DMark05, killing the RS480M2 by more than 330 points.

The same was true in our PCMark04 testing. The Overall PCMark04 score of 4666 wasn't even close to the others. Like the 3DMark05 test, the top score in

this category also went to the ASUS A8N-SLI, which recorded a 5236 score, 570 points better than the MSI board. The runner-up, the Abit AX8, still eclipsed the RS480M2's score by 535, weighing in with a PCMark04 score of 5201.

As expected, the PCMark04 component scores of the RS480M2 were equally shaky. The 4438 CPU score, 4424 Graphics score, and the 4195 HDD score are all the troughs for their respective tests. The only component test that this MSI mobo didn't finish last in was the PCMark04 Memory test. Its 5488 beat out the 5354 recorded by the A8N-SLI board for second place.

Continuing the trend, the RS480M2 also took the bronze of this trio in our game tests. The 38.5fps rate it recorded for Doom 3 was more than a frame per second slower than the second-place AX8, which ran at 39.6fps, and it was nearly 3.5fps slower than the A8N-SLI, which clocked a rate of 41.9fps. Half Life 2 was the same story. The A8N-SLI had a smokin' 52.61fps rate, while the AX8 clocked a respectable 48.74fps, and the RS480M2 was left in the dust, with a 46.2fps score.

Final Word

Though we try to find motherboards designed for you, the computer enthusiast, this definitely didn't turn out to be one of them. This may make a nice board for the grandmother of a computer enthusiast; someone who, every now and again, will take it out for a Sunday drive, never venturing close to the speed limit.

If you're looking for a mobo you can install and forget about, this will suit you fine. However, if you need something that can take you to a new level of computing, then you'll want to pass this one by. **CPU**

by Sam Evans

Overclock Comparison 3DMark05

Abit AX8

Stock Performance	3434
Overclocked Performance	3502

ASUS A8N-SLI Deluxe

Stock Performance	3535
Overclocked Performance	3761

★ MSI RS480M2

Stock Performance	3402
Overclocked Performance	3429

AMD Athlon 64 X2 4800+ Dual Core & Albatron K8X890 Pro

We were excited to be able to use the Athlon 64 X2 processor with this trio of boards. This is a dual-core CPU, meaning of course that it contains two processing cores on one chip. This way the processor can calculate two streams of data simultaneously. AMD Says the X2 outperforms the highest-performing AMD Athlon 64 4000+ single-core processor on multitasking benchmarks by up to 30%. While we aren't looking at benchmarks specifically designed for multitasking, we were still anxious to see how this dual-core processor would help its systems in terms of overclocking.

Motherboard

This board raised a number of installation issues. When we first installed the board and powered it up, we were surprised to find that the only things that worked were the fans and a few LEDs. We switched out practically everything: the processor, optical drives, hard drive,

same thing. The last thing we could think of trying was to insert the mPOWER card that, according to the Albatron K8X890 manual, is optional. We did decide to use the card; the users guide recommended we set the jumpers to Enable, and this seemed simple enough, except that both of the motherboards we looked at had these jumpers clipped at their base and they were too short to slip a jumper cap over to ensure they were enabled. At the risk of damaging the board, we threw caution to the wind and plugged in the mPOWER card with no cap over the jumpers. We crossed our fingers and powered it up again. Voila! It worked like a charm. Again, this was extremely risky and it went against what the manual suggested, and while we were willing to lose this board in the name of science, you may feel uneasy about potentially ruining a piece of equipment that isn't exactly free.

If you can get past the installation issues, this board is pretty cool. We dug

System Specs

Processor, Motherboard & Drivers

Processor	AMD Athlon 64 X2 4800+
Motherboard	Albatron K8X890 Pro
BIOS	
Manufacturer	Award
BIOS Version	R1.10
Chipset Driver	HyperionPro v500A
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200

Common Components

Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake CL-P0006
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	Optorite DD0405 DVD RW
Floppy	NEC 1.44MB drive
Power Supply	550W Antec TruePower II-550
Case	Cooler Master Centurion

board only had two SATA ports, especially compared to that of the other members of this group. The Tul Xpress 200P has four on board, while the Gigabyte GA-K8N Ultra-SLI has eight. Not that you would ever encounter a time when you'd need eight SATA ports, but in this age of bigger, faster, and better, isn't it reassuring to know you have them?

This board is lacking a little in the SATA area, but it does come equipped with the Marvell 88E8001 gigabit LAN Chip. It also has the Realtek ALC655 audio codec, the VIA VT6307 IEEE

AMD Athlon 64 X2 4800+ Dual Core & Albatron K8X890 Pro

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.39GHz	199MHz	12	1.296	4698	4510	4776	4617	4774	3429	39.1fps	47.72fps
Overclocked Performance	2.62GHz	218MHz	12	1.65	5185	4995	5249	4662	4828	3485	39.3fps	48.3fps

video card, and memory. We tried different brands of memory in each of the slots, but to no avail. We couldn't get the system to boot at all. The only thing we didn't swap out was the power supply, which we determined was functioning properly because it powered another build without incident.

We ended up replacing the board, only to find that our replacement did the

the look, especially the blue board with purple and green DIMM slots that gave it a cool sea vibe. The earthy pinkish-red PCI Express X 16 and IDE 1 ports also added to its neat surf-and-turf look.

The K8X890 Pro certainly won't distract you with too many special features. It has a PCI-E X16 slot and a PCI-E X4 slot just above three beige PCI slots. We were a little disappointed to see that this

1394 controller, and the Winbond Super I/O W83687THF I/O controller.

The rear panel has your basics, such as PS/2 ports for your mouse and keyboard, a parallel port for printers, and a pair of com ports. However, it is missing some key components, such as a FireWire port, even though (strangely) it supports FireWire. For those of you interested in running a digital audio

line into or out from this mobo, you'll have to get an add-on device because the board has no SPDIF ports on the rear panel.

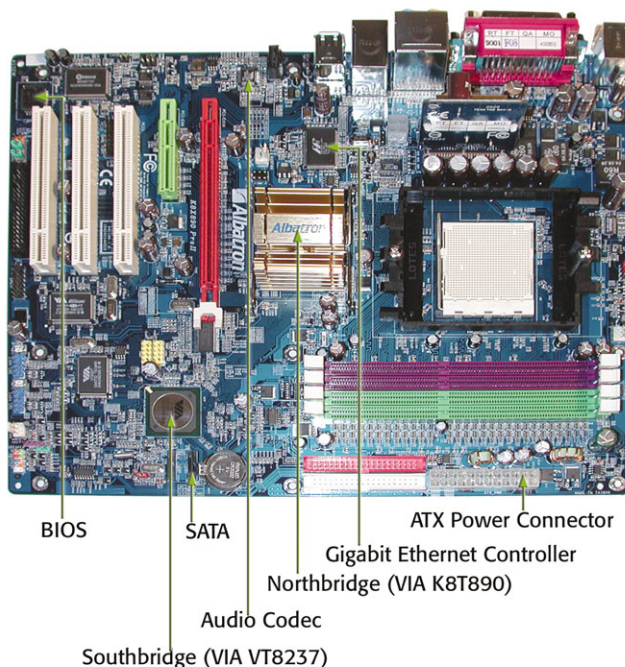
Performance

As the limited physical resources and finicky temperament of this board suggest, it wasn't the best overclocker of the group (even after we installed its latest BIOS, the Award r1.10), but it does have some redeeming qualities. One of these is the Watch Dog Timer. Once you configure your overclock settings and restart, a normal mobo will go through the POST screen and attempt to load the OS at these overclocked settings. If you get overzealous with your settings, though, you may inadvertently damage some of your OS files. This is where Watch Dog Timer comes in. If your system is unable to handle these new overclock settings during the POST tests, it will reset the configuration and reboot the system.

Though we did push this board, we never had the Watch Dog Timer reset any of our BIOS adjustments. We started our testing by gathering the benchmarks for the Albatron's stock performance. It yielded a 3429 3DMark05 score and a 4698 system score in PCMark04. Both of these scores were fairly low, and the 39.1fps and 47.72fps stock frame rates we got for Doom 3 and Half-Life 2 were good but not great. We were expecting a fairly sizeable spike when we started overclocking.

When we set our benchmarks, we noticed that this board is a liar. At default it actually underclocks the FSB and memory frequency to 199 and the core voltage to 1.296V instead of 1.3V. OK, so it's not the Watergate scandal, but it is worth noting for those of us who expect to have the full 2.4GHz right out of the box.

We were able to create a stable environment at 2.52GHz, and 2.58GHz became stable after we bumped our core



voltage up from 1.3V to 1.4V. We next tried to jump to 2.62GHz. We did get a stable environment here, cranking our CPU voltage to 1.65V and pushing the memory to 2.75V, the max recommended voltage. After that we made one last-ditch effort to get this mobo up to 2.64GHz. We did get a stable system by using the same settings as our 2.62GHz environment, but our benchmark scores actually decreased. Our 3DMark05 score dropped

from 3485 to 3260 (even lower than our stock score), while our PCMark04 system score dropped five points from 5185 to 5180. Our Doom 3 frame rate increased by 0.1fps, although (like our other benchmarks) Half-Life 2 decreased, going from 48.3fps to 47.9fps.

Comparatively, this Albatron board is the top gaming mobo of the group. The 48.3fps Half-Life 2 rate barely edged out the Tul Xpress 200P's 48.25fps for first place. Doom 3 results were similar—the Albatron took top honors with 39.3fps while the Tul wrapped up second at 38.7fps.

As we mentioned, K8X890 Pro notched a 3485 3DMark05 score, which was last place out of the three, slightly behind the 3508 from the Tul, and way behind the 3719 posted by the Gigabyte. Similarly, the Albatron was also the cellar dweller in PCMark04 system tests, behind the 5087 score of the Tul and the 6353 of the Gigabyte. Interestingly enough, the Albatron did take the top marks in the memory, graphics, and hard drive PCMark04 tests.

Final Word

The K8X890 Pro didn't fair too badly once we got it up and running. It did give us the highest graphics, memory, and HDD marks in PCMark04. It was also tops in frame rates for Doom 3 and Half-Life 2. However, it did bring up the rear in 3DMark05 and it was in the middle in PCMark04. Though it was first in three out of our four major tests, we were still a little leery of spending our paycheck on a board that was dangerous to set up. However, we'll give credit where credit is due, and it did hold its own during our overclocking session, increasing its clockspeed by well over 200MHz. **CPU**

by Sam Evans

Overclock Comparison 3DMark05

★ Albatron K8X890 Pro II

Stock Performance	3429
Overclocked Performance	3485

Gigabyte GA-K8NU-SLI

Stock Performance	3383
Overclocked Performance	3719

Tus Xpress Mainboard 200P

Stock Performance	3477
Overclocked Performance	3508

AMD Athlon 64 X2 Dual Core & Gigabyte GA- K8N Ultra-SLI

You would have to be very long-winded to list all of the features included with the Gigabyte GA-K8N Ultra-SLI. It is definitely a dream board for those who do a lot of multimedia work, but because we're interested in overclocking, let's see if the fields of USB and SATA drives can help it now.

Motherboard

Like the Albatron, the GA-K8N Ultra-SLI has a beautiful blue board, and on top of that is a bouquet of colors. It has eight red and orange SATA ports and comes with eight red and orange SATA cables, with yellow USB plug-ins and a purple FireWire plug-in. Even the blue IDE cables with bright green tips step away from the ordinary grey or black. The gold heatsink over the NVIDIA nForce4 chipset makes the GA-K8N Ultra-SLI look very sharp.

As far as setup goes, what started out easily got complicated quickly. We tried using the Qflash utility to update the BIOS, and although the new BIOS did load immediately, it wouldn't recognize our hard drive.

Security 2005, DirectX 9.0, and Adobe Acrobat Reader v5.05.

As far as onboard features go, the GA-K8N Ultra-SLI has its fair share. It has RealTek's ALC850 audio codec, which supports up to an 8-channel audio system, and it also has SPDIF In/Out connections.

This mobo also has Dual-Gigabit Ethernet ports. One port uses the Marvell 8053 chip, while the other is controlled by the VITESSE 8201.

The rear panel is also worth mentioning. Not only does it house those Ethernet ports, but it also has the SPDIF In/Out jacks, four USB ports, and your usual array of audio jacks.

Performance

Though (as we mentioned earlier) we had some trouble getting the GA-K8N Ultra-SLI going, once we did, finding the overclocking controls was easy. Before you start tweaking the settings, you'll want to go to Gigabyte's Web site (www.gigabyte.com.tw) and get the latest BIOS, version F3. This BIOS was

System Specs

Processor, Motherboard & Drivers

Processor	AMD Athlon 64 X2
Motherboard	Gigabyte GA-K8N Ultra-SLI
BIOS	
Manufacturer	Award
BIOS Version	GA K8N Ultra-SLI F3
Chipset Driver	NVIDIA nForce4 639
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200

Common Components

Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake CL-P0006
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	Optorite DD0405 DVD RW
Floppy	NEC 1.44MB drive
Power Supply	550W Antec TruePower II-550
Case	Cooler Master Centurion

Gigabyte has a field called MIT (MB Intelligent Tweaker), which houses almost all of the major overclocking settings. This is the brain of your system, where you can control CPU Frequency, Spread Spectrum, the PCI-E clock, Multiplier, and DDR voltage, just to name a few.

Before we got too crazy with the overclocking, we ran our tests at the default settings to get baseline scores. We received a 3383 3DMark05 score; however, PCMark04 gave us a bit of trouble. We tried everything we could think of with our hard drive, but we couldn't get a PCMark04 HDD score above 7.

AMD Athlon 64 X2 Dual Core & Gigabyte GA-K8N Ultra-SLI

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half- Life 2
Stock Performance	2.412GHz	201MHz	12	1.3	5570	5758	1861	3947	N/A	3383	33.8fps	27.6fps
Overclocked Performance	2.58GHz	215MHz	12	1.5	6353	6914	2015	4522	N/A	3719	37.4fps	35.7fps

We ended up going through the new BIOS and manually enabling and disabling every possible RAID configuration until the BIOS recognized our hard drive.

Once we got that taken care of, the rest of the system came together nicely. The NVIDIA utility CD has a neat feature that installs all of its drivers at once. This CD also comes with a laundry list of utilities to put on your PC, including Norton Internet

released at the end of June and supports AMD's dual-core processors, like the X2. There is also a new chipset driver, NVIDIA nForce4 v639, on the Gigabyte site that you'll want to pick up. Gigabyte has a great setup that makes finding BIOS updates and drivers very simple, and they all are very clearly marked.

After we grabbed those updates, overclocking was simple. In the F3 BIOS,

(Compare that with the 4774 and 3872 HDD scores of the other boards in this group.) We got a PCMark04 system score of 5770. Our game tests were also below average: Doom 3 ran at 33.8fps and Half-Life 2 ran at a sloth-like 27.6fps, just over half the rate of the other boards. With game scores this low, we were expecting large jumps as we started to overclock.

Next, we loaded the boards Top Performance defaults. This improved our 3DMark05 score by nearly 300 points—it jumped from 3383 to 3675. Our PCMark04 system score also jumped from 5770 to 5933, though at the conclusion of this test, the program would not give us a PCMark04 CPU or PCMark04 HDD score.

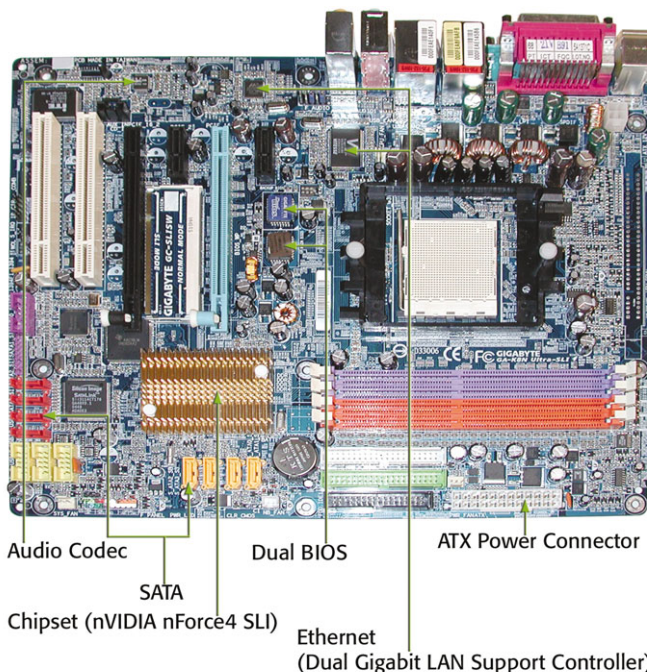
The frame rates for our game tests really picked up at these settings, as well. Half-Life 2 enjoyed a 5.5fps spike at the top performance settings, and Doom 3 went from 33.8fps to 34.7fps.

Although we were impressed with the jump these scores showed, we were convinced that we could do better manually. We got a stable environment at 2.52GHz using the default 1.3V CPU voltage and 2.65V memory setting. Next we bumped our clockspeed up to 2.58GHz. We created another stable environment here. In order to stabilize the GA-K8N Ultra-SLI at this speed, we had to go into the MIT and bump up the CPU voltage from the default 1.3V to 1.4V.

After we stabilized the 2.58GHz speed, we tried to go up to 2.64GHz (220MHz FSB coupled with a 12X multiplier), but that didn't work for us. We first walked our CPU voltage up from 1.4V to 1.45V to 1.5V. We topped out at 1.65V without any luck. Next, we bumped our memory voltage up to its recommended maximum, 2.75V. (You can also do this in the MIT.)

Despite our inability to get immediate results at 2.64GHz, we weren't ready to give up. Using the MIT settings, we pushed the chipset core voltage. First we increased it by 0.1V, then 0.2V. After Windows still wouldn't load, we increased the HT-Link voltage the same way, but we were still denied a stable system.

Then we started backing down a little bit. We weren't able to get another stable environment until we were back down at 2.58GHz, but we did manage to improve our scores from our previous visit by a few



points. We backed our memory voltage down to 2.65V and left our CPU voltage at 1.5V, 0.1V higher than the previous setting at 2.58GHz. Our 3DMark05 score jumped from 3712 to 3719 (not a huge leap, but a significant step nonetheless). Our PCMark04 system score was 6353, and our game frame rates topped out at 37.4fps for Doom 3 and 35.7fps for Half-Life 2.

When you compare the 3DMark05 score of GA K8N Ultra-SLI to the Albatron K8X890 Pro and the Tul Xpress 200P, it

looks like the latter two are in for a long day. The GA K8N Ultra-SLI posted a score of 3719, over 200 points higher than its closest competitor, the Xpress 200P, whose 3508 score just beat out the 3485 put up by the K8X890.

The PCMark04 system scores showed a similar trend. The GA K8N Ultra-SLI was way out in front, scoring 6353 with the other two boards finishing second and third, though the order of those two did switch (scoring 5185, the Albatron bested the 5087 put up by the Tul Xpress 200P). The PCMark04 CPU score of 6914 was also tops, beating the 5014 of the Tul board and the 4995 displayed by the Albatron. After that, this Gigabyte

mobo starting losing steam. Its 4522 score finished second in the PCMark04 graphics test, and the GA K8N Ultra-SLI finished last in the PCMark04 memory and HDD tests.

After the fabulous 3DMark05 and PCMark04 system scores, we were disappointed in the game frame rates. The 37.4fps in our Doom 3 test was dead last, behind the 38.7fps of the Tul and 39.3fps yielded by the Albatron. Similarly the GA K8N Ultra-SLI couldn't compete in Half-Life 2 either. Its 35.7fps rate was way off the 48.3fps set by the Albatron K8X890 Pro.

Final Word

Talk about confusing! We just couldn't figure out what to make of this board. When overlocked, it logged the best 3DMark05 and PCMark04 scores, but it also gave us the worst Doom 3 and Half-Life 2 frame rates, and the 35.7 Half-Life 2 score wasn't even close to the competition. This is an intriguing board and the only one who broke 3700 out of the three. (Heck, the other two couldn't even crack 3600.) However, we'd like to see some higher game scores before we'd spend our paychecks on the GA-K8N Ultra-SLI. **CPU**

by Sam Evans

Overclock Comparison 3DMark05

Albatron K8X890 Pro II

Stock Performance	3429
Overclocked Performance	3485

★ Gigabyte GA-K8NU-SLI

Stock Performance	3383
Overclocked Performance	3719

Tul Xpress Mainboard 200P

Stock Performance	3477
Overclocked Performance	3508

AMD Athlon X2 & Tul Xpress Mainboard 200P

Designed to respond to an increase in system bandwidth, the Tul Xpress 200P worked well with the Athlon 64 3800+. We were interested to see how it would deal with the dual-core X2.

Motherboard

The Tul Xpress 200P is a sharp-looking red board that is accented well by the black and blue DDR ports and the black PCI Express X16 and X4 slots. It has a pair of beige PCI slots, along with a white power connector and blue and white IDE ports. It basically looks like the big brother to the micro ATX RS480-M from MSI. Coincidentally, these pseudo-siblings also feature ATI Radeon Xpress chipsets.

The ATI Radeon Xpress 200P that the Tul Xpress 200P styles has the RX480 Northbridge alongside the SB400 Southbridge. The RX480 is a discrete chipset compared to the video-integrated RS480 Northbridge of the Xpress 200.

The SB400 chip supports the native ITE IT8712F-A super I/O chip, as well as the Realtek ALC850 audio codec that

port, and your basic PS/2 ports for your mouse and keyboard. The panel also holds four USB ports, a FireWire port, and, of course, your Ethernet port.

When you're setting this up, be careful. By default the SATA controller is set to Disabled. If you're using a SATA hard drive, go into the BIOS, navigate to the Chipset page, and select Southbridge Configuration. In there is an option called OnChip SATA Channel. Change that setting to Both. This will put you in business.

As you continue to prepare the board, go to Tul's Web site (www.tul.com.tw) for updates. You can get the latest BIOS, AX480A-940330-1, and the newest version of the AX480 flash program, version 1.34. As far as drivers go, the site houses updates for your monitor, audio code, LAN device, and SATA, as well as a new driver for the SB400 Southbridge. Also be sure to hit up ATI's Web site to get the Catalyst 5.6 chipset driver.

Performance

Once we located the SATA controller in the BIOS and enabled it, this board

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 X2
Motherboard	Tul Xpress 200P
BIOS	
Manufacturer	American Megatrend
BIOS Version	AX480A-940330-1.ROM
Chipset Driver	Catalyst 5.6
RAM	
	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200
Common Components	
Video	
	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	
	Maxtor 160GB 7,200rpm
Heatsink	
	Thermaltake CL-P0006
CPU Fan	
	Tornado Maxx F5 92mm
Optical Drive	
	Optorite DD0405 DVD RW
Floppy	
	NEC 1.44MB drive
Power Supply	
	550W Antec TruePower II-550
Case	
	Cooler Master Centurion

fairly average, and although the 40.8fps Doom 3 frame rate was higher than we'd been accustomed to seeing, the 47.73fps Half-Life 2 score fell right in line with other boards using the X2 dual-core processor.

Once we got our baseline, we disabled the spread spectrum. To do this, go into the BIOS and, in the Chipset category, look for ICS Clock Gen Configuration. The only category in this field should be Spread Spectrum. Make sure that this is disabled.

AMD Athlon X2 & Tul Xpress Mainboard 200P

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.412GHz	201MHz	12	1.3	4623	4488	3561	4423	3872	3477	40.8fps	47.73fps
Overclocked Performance	2.664GHz	222MHz	12	1.85	5087	5014	3937	4439	3889	3508	38.7fps	48.25fps

comes with the Xpress 200P. It also supports up to eight USB ports and the Realtek gigabit Ethernet chip, the RTL8110S-32.

This board has four DIMM slots with a 4GB memory max. Also, the memory channels are staggered to improve airflow around the memory.

The rear panel features S/PDIF in/out ports along with a parallel port, COM 1

didn't give us any other installation problems at all. We flashed the BIOS and got the latest drivers, and we were ready to roll.

We started our testing by running our benchmarks at the default settings of this board, so we could have a baseline to which we could compare our overclocked scores. Its 3477 3DMark05 score and 4623 PCMark04 score were

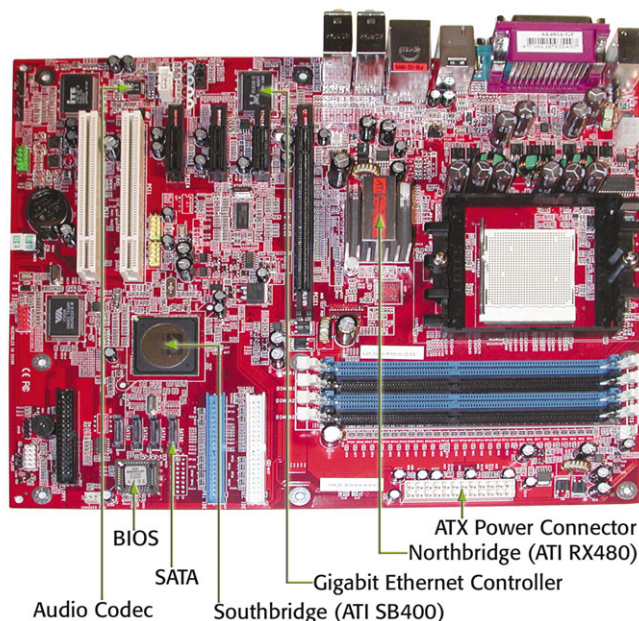
After that is done, get out of there and visit the Overclocking Adjustments page in the Advanced section of the BIOS. At the top of this screen you should see an adjustment called FID/VID Change. By default it should be set to Auto. Change this setting to Manual; this lets you change the CPU frequency and voltage, as well as the DIMM voltage and northbridge voltage.

As we started overclocking, we noticed a slightly disconcerting trend. Our memory, the Corsair XMS Xpert series, comes with a display that will flash its temperature, frequency, and voltage. We noticed that the voltage displayed on the LED was way above what we had set it to in the BIOS. For instance, when we set the memory to 2.6V in the BIOS, the memory display on our pair of Corsairs was 2.77V, 0.02V higher than the suggested maximum. Because of this discrepancy, we didn't push our memory much past 2.6V in the BIOS. Along the same lines, we noticed that, at the default setting, the FSB and memory frequency ran at 201MHz, just a tad overclocked. However, this could be because of the dual-core processor we used and not necessarily a defect in the motherboard.

We visited the Overclocking Configuration in the BIOS and changed the Frequency Multiplier from Auto to 12 and turned the FSB up to 210MHz (giving us a 2.52GHz clock speed). This environment stabilized with the voltages at their defaults, so we decided to bump the FSB up to 220MHz. We did get a stable environment here, but we had to go back into the Overclock Adjustments and push the vcore adjustment up to 1.35V, and we also had to push our memory up to the 2.6V BIOS setting.

We tried, but we were unable to get anything stable at 2.7GHz. We didn't dare push our memory any harder, but we worked our vcore voltage up, little by little, until we hit 1.9V. We also tried raising our northbridge voltage up from the default 1.2V to 1.5V, and we set the HT Link frequency to 1GHz, but nada. There were a couple of times where we eclipsed this board's maximum temperature setting, and it actually shut our system down.

All of these controls, except for the HT Link frequency, can be found in the Overclock Configuration field. To adjust



the HT Link frequency, go to the HyperTransport Configuration option in the Advanced tab. The default is Auto, but you can switch it to 200, 400, or 800MHz or 1GHz.

Our final stable environment came at 2.66GHz. Our core voltage was set to 1.85V with our northbridge at 1.5V. The memory was holding strong at the 2.6V BIOS setting, though it still appeared as 2.77V on our memory display. This environment yielded a 3508 3DMark05 score, second out of the three boards in

this group, but well behind the 3719 posted by the Gigabyte GA-K8N Ultra-SLI. The Xpress 200P was, however, bringing up the back end with a stingy 5087 PCMark04 system score. This was well behind the 6353 posted by the Gigabyte board, and 98 points away from catching the Albatron K8X890 Pro. As far as the components tests went, the Tul ran in the middle of the pack virtually the whole way through. It was second in PCMark04 CPU tests with a score of 5014, well behind the 6914 posted by the GA-K8N Ultra-SLI. The memory tests were similar. The Xpress 200P scored a 3937, which was a distant second to the 5249 put

up by the Albatron. The HDD tests were also similar with the Albatron leading the way with a 4828 score and the Tul behind it with 3889. It did, however, slip to third place in the graphics tests with a score of 4439, slightly off the 4662 pace set by the Albatron K8X890 Pro. The 38.7fps Doom 3 rate is actually lower than the stock score (40.8 fps), but it's still good enough to push this board past the 37.4fps rate the Gigabyte GA K8N Ultra-SLI posted for second place, and at 48.25fps, it was just edged out of first place in Half-Life 2 by the flat 48.3fps rate posted by the Albatron K8X890 Pro.

Final Word

Overall, this is not a bad board, even though we couldn't get it to overclock quite at the same levels as the Athlon 3800+. Although the Tul Xpress 200P did take last out of this trio in our 3DMark05 overclock, it moved up a spot in the PCMark04 system test. Also encouraging was the fact the Xpress 200P took home the gold from this group in game performance. The heat issues scared us a little bit, but the solid overclocking does pay some dividends, and we wouldn't mind using this board again. **CPU**

by Sam Evans

Overclock Comparison 3DMark05

Albatron K8X890 Pro II	
Stock Performance	3429
Overclocked Performance	3485
Gigabyte GA-K8NU-SLI	
Stock Performance	3383
Overclocked Performance	3719
★ Tul Xpress Mainboard 200P	
Stock Performance	3477
Overclocked Performance	3508

AMD Athlon 64 FX-55 & ASUS A8V-E Deluxe

For this series of case studies, we used the AMD Athlon 64 FX-55, a processor that, according to AMD, is designed specifically for gaming. A few of this processor's features include AMD's HyperTransport technology, designed to reduce bottlenecks, and the Cool'n'Quiet technology to keep temperatures and noise levels down inside your PC case. Let's see how our motherboards worked with this processor.

Motherboard

The first board we tested was the ASUS A8V-E Deluxe. As far as aesthetics go, this board has a rather subtle color display. It's black and has two pairs of black and blue DIMM slots with alternating IDE terminals of the same scheme. The PCI Express x 16 slot is also black. It is surrounded by white PCI and PCI Express x 1 slots. The SATA drives are black, as well. As far as color goes, the coolest thing on this board is the silver and black heatsink on the VIA K8T890 Northbridge. The board is plain Jane, but looks aren't everything.

V-RAID Tool software. The VIA Advanced Connectivity Suite supports eight USB 2.0 ports at 480Mbps and also has 10/100Mbps Ethernet support, though the A8V-E Deluxe also integrated a Marvell Gigabyte Ethernet port, as well. This southbridge also has the VIA Vinyl Multichannel Audio Suite. The final feature of the VT8237R is its V-MAP architecture. This ensures pin compatibility with old southbridges and makes integration easier.

One of the coolest things about this board is that it comes with ASUS's Wi-Fi-g. If you are creating a WLAN at home, this board is IEEE 802.11g-compliant. It also comes with a dipolar wireless LAN antenna that uses a 2.4GHz frequency to transfer information at rates up to 54Mbps.

Performance

Before you get started, there are a few updates you can get if you're running Windows XP x64. We also found a BIOS update, A8V-E 1006, that supports the FX-55 CPU and AMD's Cool'n'Quiet feature.

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon FX-55
Motherboard	ASUS A8V-E Deluxe
BIOS	
Manufacturer	Award
BIOS Version	1004
Chipset Driver	HyperionPro v500A
RAM	1GB (512x2) Corsair
	XMS Xpert Dual
	Channel Kit 184-pin PC-3200
Common Components	
Video	128MB NVIDIA
	GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake CL-P0006
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	Optorite DD0405 DVD-RW
Floppy	NEC 1.44MB drive
Power Supply	550W Antec
	TruePower II-550
Case	Cooler Master Centurion

The A8V-E Deluxe does come with a few overclocking features. One of these is AI NOS (nondelay overclocking system). A play on the acronym for nitrous oxide, which is a gas used to give cars an extra boost, the AI NOS senses when there is a strain on your system and overlocks certain system components as needed.

This board also has other mass overclock options. Right above the AI NOS option in the JumperFree Configuration menu of the BIOS is the Overclock

AMD Athlon 64 FX-55 & ASUS A8V-E Deluxe

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.6GHz	200MHz	13	1.5	4970	4860	4984	4706	4842	3491	39fps	47.87fps
Overclocked Performance	2.81GHz	208MHz	13.5	1.6	5306	5205	5171	4727	4883	3511	39.1fps	48.29fps

The ASUS A8V-E Deluxe is equipped with the VIA K8T890 chipset. The northbridge spotlights VIA's Hyper8 technology, which can potentially deliver an 8Gbps bandwidth transport environment. The VT8237R southbridge is divided into four parts. The Drive-Station Controller Suite offers 150Mbps speeds for SATA connections and is configurable through the

Our best overclocking scores came when we had the FSB at 208MHz and the multiplier at 13.5. If you're big on using a large multiplier, you can get a stable environment using 14. Our top FSB setting for this was only 200MHz, though. Going with a 13.5 multiplier allowed us to tailor our system a little better to get every last hertz out of our setup.

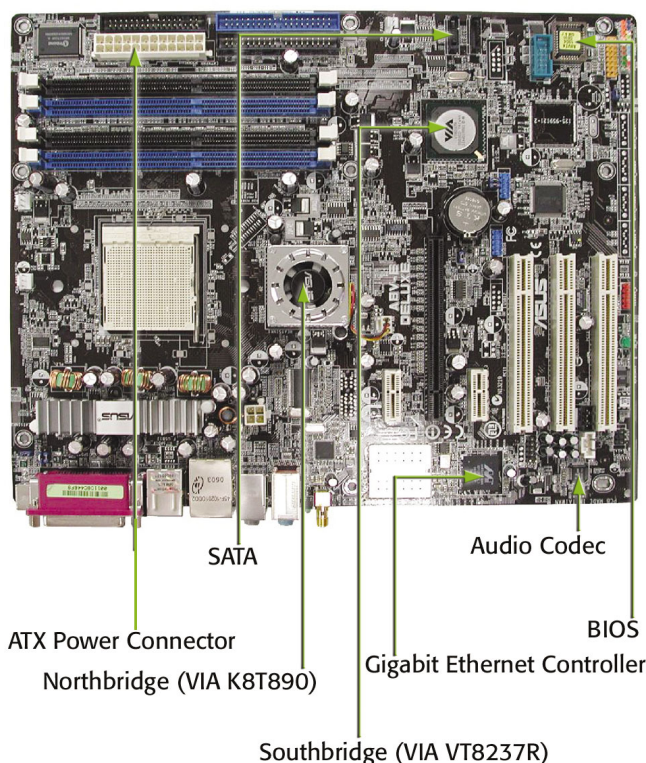
Option setting. This is kind of a generic function that allows you to choose among overclocking your system by 3%, 5%, 8%, or 10%. You can take advantage of this by switching the Overclock Profile field to AI Overclock.

We actually found that this option works very well. We couldn't get a stable environment at the 10% setting, but the 8% system overclock worked just as

well as anything we could come up with. It stabilized the system at 2.808GHz (216 FSB with a 13 multiplier). The CPU voltage was at 1.764V, while our memory was set to its maximum voltage, 2.75V, with a 216 memory frequency. This setting gave us a 3525 3DMark05 score, which increased on the stock score by 61 points. The Deluxe yielded a 5339 PCMark04 score. As far as game tests go, Half-Life 2 took a two frames per second jump (from 47.8fps to 49.6fps), while our Doom 3 scores skyrocketed from 39fps to 39.3fps.

If you are seeking total control, you'll want to disable Overclock Options and the AI NOS option. By turning the Overclock Profile to Manual, you will be able to set your own parameters. As we said earlier, our top manual overclock yielded the same clock speed (2.808 GHz) as the 8% overclock option, though we used a different FSB/Multiplier combination (208MHz FSB coupled with a 13.5 multiplier). We had our memory voltage set a 2.75V with the spread spectrum disabled and the CAS Latency set a 2.0 rather than the normal 2.5. Though we achieved the same clock speed as the 8% AI Overclock setting, our scores were a little lower. We received a 3511 3DMark05 score, a 5306 PCMark04 score, and frame rates of 39.1fps and 48.29fps in Doom 3 and Half-Life 2, respectively.

After hitting 2.808GHz, we tried to push the board a little harder by going with a 225MHz FSB with a 12.5 multiplier, giving us a 2.8125GHz clock-speed. We weren't expecting any huge disasters; after all, it was only a few megahertz difference. However, when we attempted to boot at these settings, we received an error message saying that one of our startup files had been



damaged, and we would have to insert the startup disk to repair it.

This board does a very nice job of giving you a wide range of choices and very small increments to get your system just so. The CPU multiplier has a range from 4x to 20x with 1/2-unit increments. Along those same

Overclock Comparison 3DMark05

★ ASUS A8V-E Deluxe

Stock Performance	3464
Overclocked Performance	3525

MSI K8N Neo4 Platinum SLI

Stock Performance	3562
Overclocked Performance	3608

ECS RS480-M

Stock Performance	3486
Overclocked Performance	3547

lines, the memory voltage adjustments have a range from 2.6V to 3.0V in 0.5V increments. The Hammer Vid Control also gives you plenty of wiggle room with a range that goes from 0.8V to 1.5625V, increasing by 0.0125V increments.

This board finished right around the middle of the trio that used the FX-55, beating the 5140 posted by the MSI Neo4 Platinum/SLI. It did bring up the rear in the 3DMark05 test with a score of 3525, getting edged out by the 3547 posted by the ECS board, but it still only finished less than 90 points behind the MSI mobo. The game tests were similarly jumbled. The 39.3 Doom 3 mark from the OCed ASUS finished third, but it only lost to the ECS runner up by 0.1fps. It scored 49.6fps in Half-Life 2, a solid second place finish, beating the ECS board by over 1fps, while not quite being able to overtake the 50.1fps rate put up by the Neo4 Platinum/SLI.

Final Word

While the ASUS A8V-E Deluxe isn't going to grab your attention in a lineup, it is still a solid board. Though it came in last in half of our tests, the overclocked scores jumped 52 points from the stock score in 3DMark05, which isn't too shabby, and it was perhaps the easiest to work with of the three. Installation was fairly painless and, outside of the time we had to repair the damaged startup file in Windows, we encountered no problems that couldn't be solved with a quick restart, even when we were pushing the A8V-E Deluxe to its limits. **CPU**

by Sam Evans

AMD Athlon 64 FX-55 & MSI K8N Neo4 Platinum/SLI

For our second board, we chose the MSI K8N Neo4 Platinum/SLI. This board features a slew of enhancements from MSI, including DigiCell, CoreCell, and CoreCenter technologies, all of which we hoped would lead to some sick overclocking scores.

Motherboard

Although this board might have the visual edge in the group when it comes to most colors used on a board, its display is rather unique, to put it nicely. Between the teal and purple DIMM slots, the yellow IDE ports, the beige PCI Express slots, the green USB ports, and the purple SATA ports, this board is a true rainbow of color. (That doesn't even include the Red IDE cables and bright orange SATA cables that come packaged with it.)

However, the board's specs are solid. It features the NVIDIA nForce4 SLI chipset, which includes the HyperTransport technology supporting transfer rates of up to 1GHz.

PCI Bus slots. The top two slots are your basic beige, but the bottom one, which is designated as a communication slot, is a bright orange.

This board comes with six SATA ports. NV RAID will support four of these devices. However, the board also comes with a Silicon Image SATARaid support disc so that you can take advantage of the fifth and sixth SATA ports. The NV RAID supports RAID 0, 1, 0+1, or JBOD setups.

You'll also find dual LAN jacks, and the first of these supports 10/100/1000 Fast Ethernet by nForce4 SLI, while the second is a PCI Express LAN-supported 10/100/1000 Fast Ethernet controlled by the Marvell 88E8053.

Another cool feature is that the board can support up to three FireWire ports and 10 USB 2.0 ports, and on the rear panel, you'll find one of the FireWire and four of the USB 2.0 ports.

This package includes 24-bit audio quality powered by Creative Labs'

System Specs

Processor, Motherboard & Drivers

Processor	AMD Athlon 64 FX-55
Motherboard	MSI K8N Neo4 Platinum/SLI
BIOS	
Manufacturer	Award
BIOS Version	v3.3
Chipset Driver	nForce v6.53
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200

Common Components

Video	128MB NVIDIA GeForce 6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake CL-P0006
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	Optorite DD0405 DVD-RW
Floppy	NEC 1.44MB drive
Power Supply	550W Antec TruePower II-550
Case	Cooler Master Centurion

and drivers, but if you know what you're looking for, you'll find it eventually. As of press time, the latest BIOS driver for this board was v3.3. Make sure you grab it to get the best overclocking results.

As in the previous case study with the ASUS board, the MSI K8N Neo4 Platinum/SLI also has an overclocking device built right into the BIOS for you. However, unlike the ASUS board, MSI took the time to give each one of these settings in its Dynamic Overclocking function cool military names. Private, the first level of overclocking, increases the CPU frequency by 1%. Sergeant,

AMD Athlon 64 FX-55 & MSI K8N Neo4 Platinum/SLI

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half- Life 2
Stock Performance	2.6GHz	200MHz	13	1.5	4822	4792	3332	4456	4726	3562	51.7fps	50.8fps
Overclocked Performance	2.828GHz	202MHz	14	1.55	5140	5145	3454	4475	4736	3608	51.8fps	50.1fps

The memory support is fairly typical of AMD-based ATX boards. It supports DDR 266/333/400 modules in four 184-pin slots. Each memory slot can hold up to 1GB, for a 4GB total.

The MSI K8N Neo4 Platinum/SLI features dual PCI Express x16 slots to enable SLI performance. The second of these slots is also compatible with PCI Express x1. This board also has three

Sound Blaster Live! It has six audio ports including Line In/Line Out ports, a rear speaker output, subwoofer output, mic line, and an S/PDIF Out-Optical port. Also included is an S/PDIF Out-Coaxial port.

Performance

MSI's Web site is a little sloppy when it comes to posting new BIOS updates

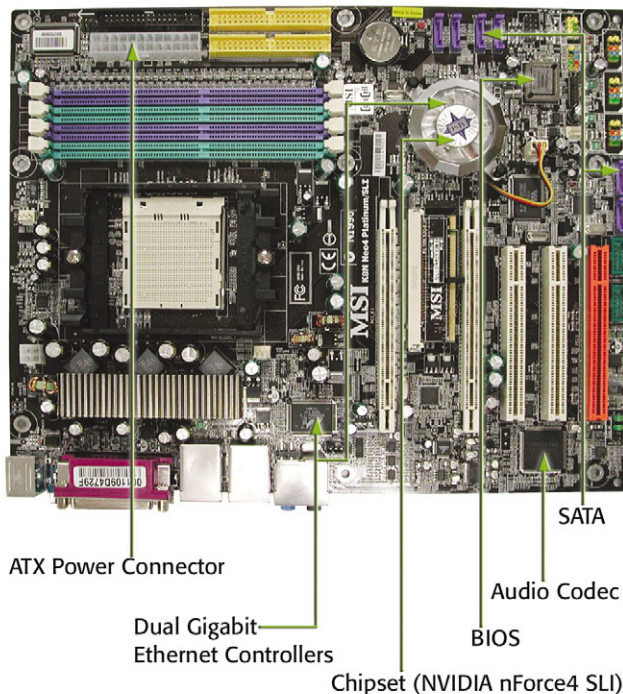
the second level, increases the CPU frequency by 3%. The third level of overclocking is Captain. This increases the CPU frequency by 5%, and this is also the default value when you load the Optimized Defaults. Colonel, General, and Commander round out the overclocking levels with CPU frequency increases of 7%, 9%, and 11% of the default setting, respectively.

This system worked well. To get to it, go into the BIOS. Enter the Cell Menu, and you should see the Dynamic Overclocking field; it's the fourth option down. Highlight it and press ENTER. Now you should be able to select the setting you want. We got stable readings from every level except Commander and General, where our system rebooted while we were running 3DMark05. The Colonel setting, which increased our CPU frequency by 7%, yielded a 3DMark05 score (3590) that was just a little bit under the score of our top manual setting (3608).

We appreciated the chipset voltage options. The small increments used in this setting, as well as the CPU and Memory Voltages, really allowed us to get the most out of this board. If you're somewhat new to overclocking, this board is very helpful. On the major voltages, it gives you a nice color code to follow so that you don't push your system too hard. The default levels are set in gray text. The high performance settings are in yellow text, while the high voltages that can make a system unstable are in bright flashing red. Indeed, it is almost hard to *not* understand just what you are doing with your voltages on the K8N Neo4 Platinum/SLI.

When you are ready to start adjusting your settings manually, go into the BIOS and then navigate into the Cell Menu field. This houses the main overclocking variables. Check to make sure the Aggressive Timing and Dynamic Overclocking settings are disabled and the High Performance Mode is set to Manual. From there you can adjust FSB Frequency, the Multiplier (which is found in the Adjust CPU Ratio field), and the CPU voltage. Just below that you'll find adjustments for the CPU, memory, and chipset voltages.

For our first test, we ran the board using the default settings. These scores



were interesting, to say the least. While the K8N Neo4 Platinum/SLI gave us the highest stock score of this trio of boards in 3DMark05 (3562), it also yielded the worst PCMark04 score, 4822.

Once we gathered our stock scores, we started nudging the FSB up. Everything was stable until we tried our system at 2.795GHz; there we received an error in 3DMark05. After we bumped the CPU voltage from 1.5V to 1.525V,

we were good to go again. We got a stable environment at 2.821GHz, though we had to raise our CPU voltage to 1.55V, our memory voltage to 2.75V, and our chipset voltage to 1.65V. The 3636 3DMark05 score was one of the higher scores we saw on a stable system, and the 5197 PCMark04 score wasn't bad either.

We achieved a top clock speed of 2.828GHz. We multiplied a 202MHz FSB with a 14 CPU ratio. Our memory voltage was set at 2.75V, and our chipset was set to 1.5V. Though we had a higher clock speed, we noticed that our 3608 3DMark05 score and 5140 PCMark04 score were a little lower than

at some of the lower settings. There wasn't much difference in frame rates when compared to its stock performance. In fact, the Doom 3 scores were 39.7 for both the stock and the overclock tests. The Half-Life 2 frame rate actually decreased with the overclock going from 50.8fps to 50.1fps.

Final Word

It's hard to pick a clear-cut winner out of this group, but the MSI K8N Neo4 Platinum/SLI certainly held its own. It was the only board to run Half-Life 2 at over 50fps. It was also the only board we could get to break 3600 in 3DMark05 using an environment that we consider stable. However, this board did finish in a distant third place in PCMark04. When it's all said and done, though, this was an easy board to work with. Manual overclocking was simple, and the adjustments were well-defined. This is a solid board for anyone looking to reap the advantages of overclocking. **CPU**

by Sam Evans

Overclock Comparison 3DMark05

ASUS A8V-E Deluxe

Stock Performance	3464
Overclocked Performance	3525

★ MSI K8N Neo4 Platinum SLI

Stock Performance	3562
Overclocked Performance	3608

ECS RS480-M

Stock Performance	3486
Overclocked Performance	3547

AMD Athlon 64 FX-55 & ECS RS480-M

After finishing up with the MSI board, we moved on to ECS's RS480-M, a micro ATX board that has been garnering praise for using the ATI Radeon 9600 as the basis for its onboard graphics. Though we were using a different video card, we were still expecting big things from this micro board.

Motherboard

Although this board is equipped with a nice array of features, it might not be the most aesthetically pleasing. It has a purple board, trimmed with a pair of blue memory sockets and a blue primary IDE channel sandwiched between a white floppy connector and secondary IDE channel. Needless to say, this isn't a color scheme you'll likely see on a model strutting down a runway in Milan anytime soon, but functionality is what we care most about here.

The RS480-M is centered on the ATI RS480 chipset, which is the first to come equipped with a DirectX 9.0 graphics core. The Xpress 200 also features ATI's HyperMemory technology, allowing the graphics card to use more onboard memory.

It also has the Realtek RTL8100C 10/100 Ethernet controller for LAN access.

There are a few driver updates on the ECS Web site that you'll want to pick up. ECS recently released a BIOS update for this board that addresses a number of issues, including CPU support updates for the FX-55 and FX-57 and improving the stability of the SATA RAID.

Performance

Overclocking this motherboard was certainly an adventure. After we installed the board, it loaded our Windows setting from our hard drive without incident, which is nice because if you're just replacing your board, you won't have to reformat your drive to install a fresh copy of your OS. However, when we checked the BIOS, we noticed that if you're going to load Windows from a CD, you should change the boot device order so that CD-ROM is first. To do this, enter the BIOS by pressing Delete when prompted at the POST screen. Go into the Advanced BIOS features. About halfway down the page, you'll see cate-

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 FX-55
Motherboard	ECS RS480-M
BIOS	
Manufacturer	Phoenix Award
BIOS Version	1.0f
Chipset Driver	ATI Catalyst 5.6
RAM	1GB (512x2) Corsair XMS
	Xpert Dual Channel Kit 1
	84-pin PC-3200
Common Components	
Video	128MB NVIDIA GeForce
	6600GT PCI-E
Hard Drive	Maxtor 160GB 7,200rpm
Heatsink	Thermaltake CL-P0006
CPU Fan	Tornado Maxx F5 92mm
Optical Drive	Optorite DD0405 DVD RW
Floppy	NEC 1.44MB drive
Power Supply	550W Antec TruePower II-550
Case	Cooler Master Centurion

Frequency/Voltage Control field, where you will see a setting for AMD's K8 Cool 'n' Quiet control. Under that is a setting called Hammer Fid Control. This serves as your CPU multiplier. We were a little disappointed to see the 1X multiplier increments. While this may suffice for some, we wouldn't mind seeing 0.5-unit increments on the multiplier setting, in order to improve manual control.

The control below that, which is Hammer Vid Control, is your CPU voltage control. ECS did a nice job with the increments in this controller, increasing each option by 0.025V, but the

AMD Athlon 64 FX-55 & ECS RS480-M

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.6GHz	200MHz	13	1.5	5100	4889	5699	4461	4188	3486	54.4fps	48.2fps
Overclocked Performance	2.81GHz	201MHz	14	1.55	5466	5269	N/A	4468	4278	3547	51fps	48.5fps

Other features on this board include a Radeon X300-based 2D/3D graphics engine, along with a PCI Express x16 slot and three PCI slots. It has two 184-pin DDR slots with a 2GB limit. It can support four Ultra DMA 133/100/66 devices and four SATA devices and also features RAID0 and RAID1 configuration.

The SB 400 southbridge supports the Realtek ALC655 6-channel audio codec.

gories for First Boot Device, Second Boot Device, and Third Boot Device. If you want to load an OS from a CD-ROM, change the First Boot Device to CD-ROM. Then save your changes by pressing F10 and selecting Y.

Now that we had the best drivers for the job, we jumped into the Phoenix Award BIOS. If you want to get into the good stuff right away, head for the

maximum voltage you can give your CPU is 1.55V.

After you select your CPU voltage, skip down to CPU Clock. The default is 200MHz, but you can enter any number from 200MHz to 250MHz.

If you're looking for further modifications to make to your BIOS after you set your CPU clock, you can disable the spread spectrum to devote what

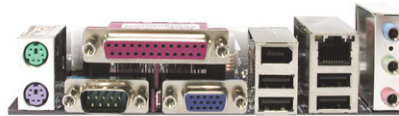
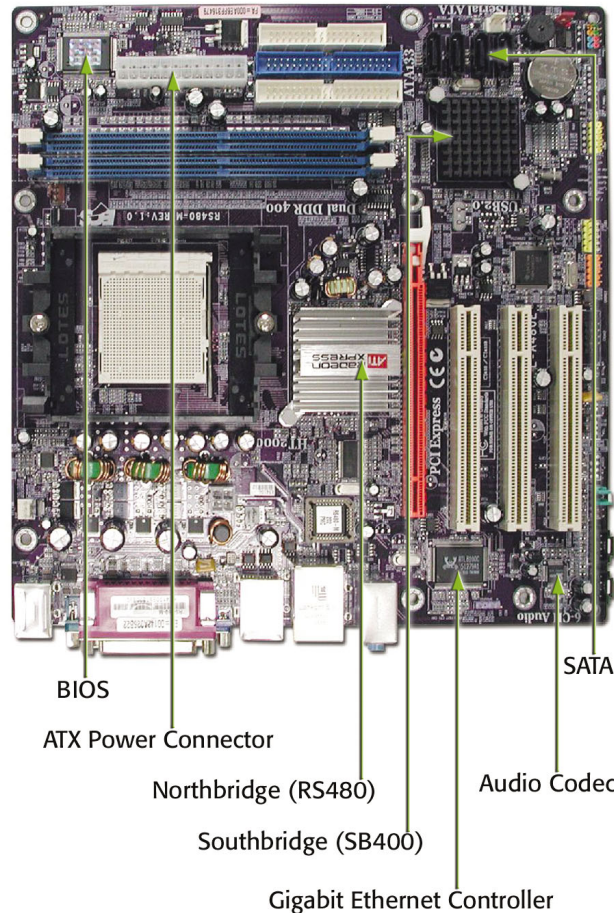
energy it uses to increasing your performance.

Right below the spread spectrum is the DIMM Voltage control. By default this is set to 2.6V but be sure to check your memory specifications for its maximum voltage—you may be able to give your DIMMs a little more juice.

There are certainly plenty of variables for you to control, but here's what worked for us. The RS480-M recorded fairly high scores at the stock settings. The 39.3fps it posted in Doom 3 was second among the three boards of this group, and the 5100 in PCMark05 dwarfed the runner-up, the ASUS A8V-E Deluxe, by 130 points.

When we started to over-clock it, we wanted to see what we could do with the multiplier. We bumped it up to 14 and we still had a stable environment, with a 3547 score in 3DMark05. Next we said a quick prayer, wiped our sweaty palms on our pants, and bumped the multiplier up to 15. After we restarted our computer, nothing happened. Our VGA connection to our monitor temporarily shorted out, and this board wasn't able to run the memory test in PCMark04 again. Even after we cleared the CMOS, reset the board to its Fail-Safe Defaults, formatted our hard drive, and reloaded Windows, we still couldn't get the memory tests to run properly. Every time we tried, our PC would freeze, and then we'd have to restart and actually uninstall and reinstall PCMark04 just to get it to load without erring. However, diagnosing this problem is tricky. We can't blame the motherboard because it's possible we damaged the memory during the boot up; however, we can't necessarily blame the faulty memory either, and far be it for us to blame ourselves for attempting a jump that large.

After that, we went back to a multiplier of 14. We tried 203MHz, and although it



loaded Windows, our system crashed out of 3DMark05. After a few more tries, we were able to get a stable system at 201MHz with a 14 multiplier, though we did go back and raise the CPU voltage to 1.55V.

Overclock Comparison 3DMark05

ASUS A8V-E Deluxe

Stock Performance	3464
Overclocked Performance	3525

MSI K8N Neo4 Platinum SLI

Stock Performance	3562
Overclocked Performance	3608

★ ECS RS480-M

Stock Performance	3486
Overclocked Performance	3547

In a scoring comparison, the RS480-M performed decently taking top spot out of the three boards in this group in the PCMark04 system test. The 5466 it posted beat out the 5306 put up by the ASUS A8V-E Deluxe, and left the 5140 of the MSI K8N Neo4 Platinum/SLI in the dust.

However, the ECS couldn't keep the momentum rolling in the 3DMark05 test. Its 3547 came in second to the K8N Neo4 Platinum/SLI, which posted a 3608. It did beat the A8V-E Deluxe's 3511, though.

Keeping the pace it set in 3DMark05, the ECS RS480-M split the ASUS and the MSI boards in our game tests. It came in second in both. The RS480-M had a 39.4fps rate. This split the difference between the 39.7fps the MSI put up and the 39.1fps the ASUS A8V-E Deluxe posted. Half-Life 2 had the same 1-2-

3 order with the 48.5fps rate of the ECS playing bridesmaid to the 50.1fps from the K8N Neo4 Platinum/SLI. The ASUS, however, did make up some ground on the ECS. Its 48.29fps inched closer to second, but it still wasn't quite enough to garner the crown.

Final Word

Overall this board handled most of our benchmarks just fine. The ECS RS480-M edged out the ASUS A8V-E Deluxe for second place in Doom 3 and Half-Life 2 and it did manage to muster the top PCMark04 score, 5466. As long as you treat this board with a little TLC and don't get too overzealous with your overclocking, you should be just fine with the ECS RS480-M. **CPU**

by Sam Evans

Born To Run

Our Modded, Watercooled Rig Flexes Its Muscle

We build some top-shelf rigs for each *PC Modder* issue. But these computers are test systems, so we generally ignore aesthetics and substitute low-end components that don't affect performance. Thus, our lab has a half-dozen or so ugly machines that sport cheap, loud fans and CD-ROMs that are well past their prime.

This time around, we decided to change the scenery. We commissioned case-cutting pro Bill Owen of MNPCTECH (www.mnpctech.com) to mod a standard AMS gTower CF-1009. The theme: a Corvette Stingray. Owen came through with a jaw-dropping work of art (see "Case Cutters" on page 157), and we filled the system with the latest and greatest gadgetry. We'll show you how we built our new hot rod.

Shopping With The Company Card

Most computer enthusiasts with an unlimited budget might ignore prices in the quest for power, but we found ourselves tallying every last component just to see how wild our shopping spree really was. The cost of our computer's parts came to a whopping \$5,213—and that figure doesn't even include the cost of our heavily modded case. However, the total does include the price (about \$1,109 online, as we go to press) of one component we didn't buy: AMD's Athlon 64 FX-57. AMD loaned us the chip before the FX-57 reached retailers, so we could put the CPU through its paces in this system and our AMD-based "Race For The Gold" (page 98) contender.

With AMD's latest FX chip in hand, we poked around for a motherboard that could handle some heavy overclocking. Although the ASUS A8N-SLI Deluxe was one of the very first mobos on the SLI



scene, we didn't hold the board's age against it. In fact, we wanted a proven motherboard; ASUS recently released the mobo's seventh BIOS revision, so we expected that the board maker had worked out most of the kinks. (As it turned out, there were kinks aplenty—the beta BIOS version saved our system from permanent toasterdom.) The A8N-SLI Deluxe isn't cheap at \$175, but it has some great features, including the two x16 PCI-E slots (which each run at x8 in SLI mode) and two RAID controllers that support a total of eight SATA connectors (four at 3Gbps and four at 1.5Gbps).

Speaking of expensive components, our power supply's price tag weighed in at a heretofore-unheard-of \$489.95. PC Power & Cooling became king of the PSU wattage hill when it introduced its 850W Turbo-Cool 850 SSI, which boasts a 950W peak and has separate PCI-E graphics card connectors that each draw power directly from the power supply. The PSU has 24-pin and

8-pin motherboard connectors but includes 20-pin and 4-pin adapters for older connectors. PC Power & Cooling sleeves this beast in silvery mesh before shipping it to retailers, but we wanted sleeving that matched our rig's theme, so we bought the supply from online retailer Performance-PCS.com, which custom sleeves power supplies. It can also transform a standard PSU into a modular PSU, but we didn't have any need for a modular device. We selected the red sleeving and then shipped it straight to MNPCTECH.

Although NVIDIA released its GeForce 7 series GPUs just before we wrapped up this issue of *PC Modder*, it wasn't available when we first shopped for parts, so we grabbed the baddest cards at the moment: a pair of 512MB BFG Tech NVIDIA GeForce 6800 Ultras, for a total price of \$1,768. We also rounded up two 1GB kits of Corsair XMS TWINX1024-4400C25PT and twin 73GB, 10,000rpm Western Digital WD740GDRTL Raptor hard drives.

A large budget can buy some fantastic air cooling gizmos, but it can also buy some top-shelf watercooling equipment, so we took the company plastic to Danger Den's newly revamped online store (www.dangerdenstore.com). Dan Stephens, owner and VP of Sales and Marketing, suggested that we skip the traditional tube clamps in favor of a simple, but little-known, tube attachment method. Dan pointed out that although tube clamps (which squeeze the hose to a device's fittings) create watertight seals, you can create a stronger seal by slipping small tubes over larger fittings.

This method defies conventional wisdom: Instead of matching 1/2-inch ID (inside diameter) tubing to 1/2-inch OD (outside diameter) fittings, we ordered waterblocks and devices that had 1/2-inch



It's too bad the GPUs sit on the lower sides of the graphics cards. We'd love to watch the neon fluid flowing through the waterblock channels.

OD fittings, but then bought 3/8-inch ID tubing. Without heat, the tubing won't fit over the nozzles, but once you dip the tubes into hot water, you can slide them on easily. "After you bring the water to a boil, you take one end of the tubing and place it in the boiling water for about 15 seconds, then quickly push the hot, soft end of the 3/8-inch tubing onto the larger 1/2-inch fitting," Stephens says. "You will note that it will easily bend, so you need to push it straight on all the way down the fitting."

We selected a silver CPU waterblock, a copper chipset waterblock, and a pump. We then turned our attention to the video card waterblocks. Danger Den's NV-68, which handles any GeForce 6800 video card, is an intimidating hunk of acrylic and metal that weighs in at 2 pounds. We bought the NV-68SLI kit, which includes two of the NV-68 blocks, a short tube that lets water flow from one block to the next, and two clamps. Users who plan to use dual GeForce 6800 cards should be sure to buy the kit instead of buying the blocks individually, as the single blocks have two fittings that face in the same direction. The kit's blocks have opposing fittings, so the blocks can easily connect to each other. The only motherboard line that has x16 PCI-E slots far

enough apart to accommodate the hulking NV-68's is the ASUS A8N-SLI.

The Build

Owen installed the radiator, PSU, fan controller, and the rig's eight fans before

shipping the Stingray chassis to us, but it was still nothing more than a really cool paperweight. As soon as the red and black enclosure returned from its photo shoot, we began installing the heart and brains of our newest toy, er, computer.

Mobo assembly. Stephens suggests assembling your system and attaching all waterblocks before attaching tubes via the boiling water method. After popping the FX-57 into its socket, double-checking the locking mechanism and applying a daub of Arctic Silver 5 (www.arcticsilver.com), we assembled the CPU block, which was much easier than expected. You slip two long, threaded rods through the motherboard backplate and the holes on either side of the CPU socket, then slide the waterblock onto the CPU and add some washers, springs, and nuts.

Video card surgery. Installing the graphics cards was a straightforward, but risky and time-consuming process. Think twice before you take the knife to your graphics card if you can't afford to replace it. Both cards must have identical BIOS versions in order to communicate with each other, so run each card separately in the motherboard's primary slot and check

Specifications

System		
Component	Model	Price
Processor	2.8GHz AMD Athlon 64 FX-57	\$1,109
Motherboard	2GB Corsair XMS DDR550 TWINX1024-4400C25PT (512MB x 4)	\$532*
Graphics	512MB BFG Tech BFGR68512UOCX NVIDIA GeForce 6800 Ultra PCIe (x2)	\$1,768*
Hard Drive	73GB, 10,000rpm Western Digital Raptor WD740GDRTL SATA 150 (x2)	\$470*
Optical Drive	Plextor PX-740A	\$92.99
Power Supply	850W PC Power & Cooling Turbo-Cool 850 Ultra SSI	\$489.95
Sound	Creative Labs Sound Blaster Audigy 2 ZS	\$93
Watercooling		
Pump	Danger Den DD-D5 12V	\$74.95
Radiator	Hardware Labs Black Ice Xtreme III	\$77.99
Reservoir	Danger Den Dual 5.25-inch Bay Reservoir	\$31.95
Fluid	Danger Den MCT-5 (x2)	\$41.98*
Tubing	Tygon 3603 3/8-inch ID, 5/8-inch OD (x15 feet)	\$35.25*
CPU Block	Danger Den Silver TDX Block for Athlon64 & Opteron 754/939/940	\$124.95
Graphics Block Kit	Danger Den NV-68SLI	\$232.95
Chipset Block	Danger Den ASUS A8N MAZE4	\$38.50
Grand Total:		\$5,213.46

*Total cost for multiple items.

the display properties for the BIOS version before you remove the fans.

Luckily, BFG Tech uses screws to secure the fan to the card, so we easily unscrewed the fan and then removed the bulky copper heatsink. We washed the thermal pads off each memory chip and the large GPU. The pads sloughed off the cards easily, as we used 91% isopropyl alcohol. It also didn't hurt that we hadn't used the video cards long enough to melt the pads.

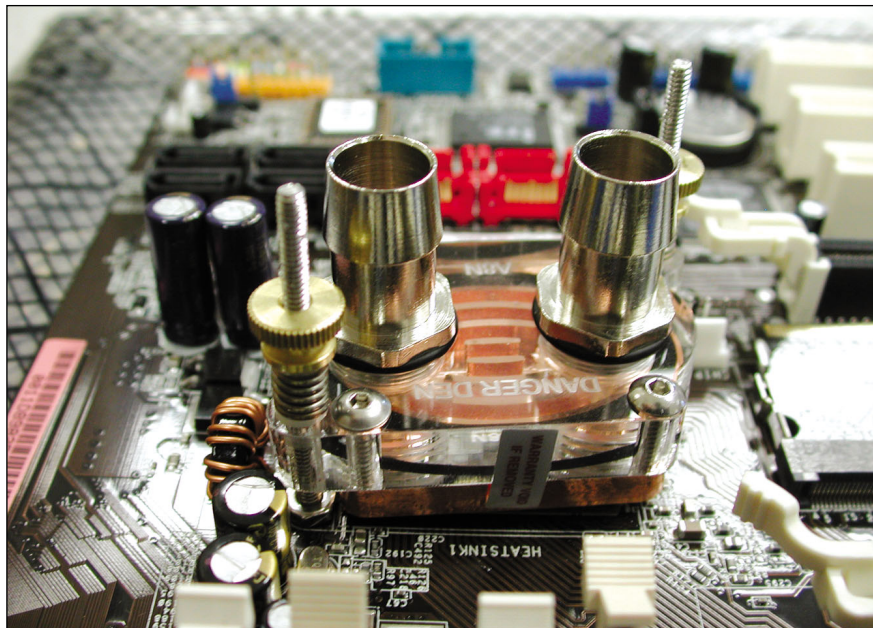
The NV-68SLI kit included two tubes of thermal grease, so we spread the white grease over the memory and the GPU. Next, we grabbed the video card waterblock's acrylic backplate and foam padding, aligned their holes to the board's holes, and then attached them via four long screws that extended well past the other side of the card. We slid the waterblock onto the screws so that the backplate and waterblock sandwiched the card and then added springs, washers, and nuts similar to those that secured the processor and motherboard chipset waterblocks.

The included connector tube has a larger ID than our other tubes, so it slipped easily (and without hot water) over the two flat connectors that bridge the small gap between the cards. If you use the kit, be sure to attach the connector tube onto the fittings that have flat ends. If you attach them via the fittings that have tapered ends, the cards will stand too far apart, which means you won't be able to attach the board's SLI Connector. We worried that the kit's plastic clamps might not create a particularly sturdy seal, but we decided to give it a try. We secured each clamp over the fittings.

Tubing. We bought tubing from a local hardware store but found that the thin tubing (3/8-inch ID, but only 1/2-inch OD) kinked whenever it rounded a corner. Our Stingray case was a little cramped, thanks to our double-sized 5.25-inch bay reservoir, dual video cards, and other space-hogging components, so we bought about 15 feet of Tygon 3603 3/8-inch ID tubing from Danger Den. This tubing, which has a 5/8-inch OD, handled most corners without kinking.

Our managers know better than to let CPU staffers play with fire, so we ruled out boiling water right away and searched for an alternative heat source. As it turns out, our coffee machine also has a spout

Thanks to our cramped case, we weren't able to split the water flow (we would have used a Y-adapter) so that cool water from the pump flowed directly to the both the CPU and the video cards.



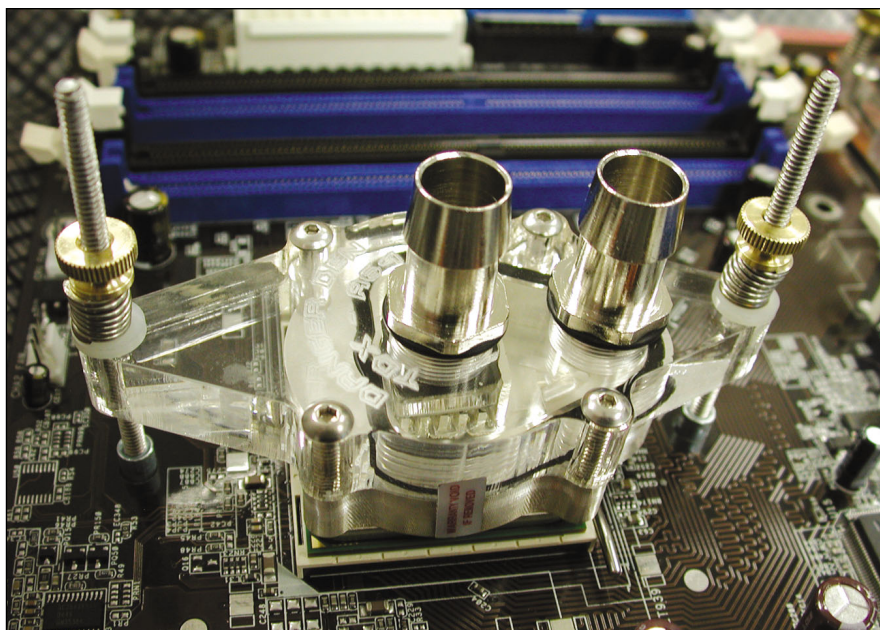
Take a good look at Danger Den's A8N MAZE4 chipset block before you install it because you'll never see it again: The block sits between the bulky graphics cards.

for hot water (ah, the wonders of technology), so we poured some steaming H₂O into a mug and then dipped in one end of the Tygon tubing.

Although Stephens recommended dipping the tube for 15 seconds, we found that our hot water didn't soften up the tubing very much after such a short dip. But a minute later, the tubing was plenty pliable, so we popped it onto the first fitting. Generally, the tubing slipped onto the fitting without much effort, but in some cases, we needed to push for a few seconds to finish the job. If you try this method, make sure you heat several inches of the tube at once—if you heat only the tip of the tube, the cool portion will stick on the surface of the fitting. Also, be sure to let the heated portion of the tube cool before you bend the tube, as it can kink when soft. We avoided this problem by attaching one tube and then moving on to a different tube before attaching the other end of the first.

We tried to make the setup work, but we ran into kinking problems. The close quarters also made it difficult to direct the water from the pump to the CPU block. We turned it around and sent the flow from the pump to the video card blocks, then to the chipset block, and finally to the CPU block. From there, the water flowed up to the gargantuan radiator and then returned to the reservoir, which fed the pump.

At least, that's what happened after we fixed the leak. As soon as we poured some of the MCT-5 fluid into the reservoir, the green fluid dribbled out of the tube between the graphics cards. We hadn't poured much fluid into the watercooling system, so we were able to stop the leak before much of it touched the lower graphics card. We readjusted the clamps, restoring the seal, and then refilled the reservoir. This time the system didn't leak, and once we started the pump, it quickly worked out the few visible air bubbles.



Danger Den's Silver TDX CPU waterblock looks cool and keeps our processor positively chilly.

We Have Power

Once we finished plugging in the cords, we pressed the Stingray's modified Bulgin power button and watched our system spring to life. We flashed the BIOS to version 1011 (the latest official BIOS), checked the system's health (the CPU monitor showed a cool 26 degrees Celsius), and then entered the SLI-configuration menu, which is in the Advanced section. We left EZ Plug Warning on Enabled but changed the SLI Broadcast Aperture to Auto and set

the AI-Selector to Dual Video Card. Next, we skipped over to the Onboard Devices Configuration menu (also in the Advanced section), entered the NVRAID Configuration area, and then set Enabled in the RAID Enabled field, which let us enable First SATA Master and Second SATA Master.

We saved the changes, rebooted, and then entered NVIDIA's RAID utility by pressing F10 during POST. Next, we chose Striping in the RAID Mode field and set the Striping Block field to 128K. Finally, we highlighted our two hard

drives and moved them from the Free Disks section to the Array Disks section. The result: a screaming-fast RAID 0 setup. We started the Windows XP Pro SP2 installation and loaded the SATA drivers when prompted, then finished the Windows installation and loaded the latest NVIDIA chipset drivers at the time, 6.66.

Disaster Strikes

Computer problems often morph from intriguing to annoying to depressing, and the calamity that struck our prized computer cycled to the latter all too fast. Our system appeared to be in great shape when we installed the latest NVIDIA graphics drivers (77.72). But when we entered the GeForce properties and highlighted the SLI multi-GPU section, we faced a page informing us that our rig boasted a SLI-capable card and that we would need to add another video card to use SLI. The window should have included an Enable SLI Multi-GPU checkbox.

From that moment forward, we ran into a variety of weird problems. In some cases the computer would blue screen during startup, until we uninstalled all of the NVIDIA drivers. In other cases it would accept the drivers just fine, but the GeForce properties wouldn't recognize the second card. Several times the rig accepted the drivers, and GeForce properties displayed the Enable SLI multi-GPU checkbox. But when we checked the box and restarted the PC, its Display Properties section wouldn't show the GeForce properties section at all, and the computer was unstable. The CPU staff tried everything we could think of, including using legacy drivers (the BFG techs recommended the 77.5 graphics driver, but it met the same fate as

Benchmarks

The AMD Athlon 64 FX-57 responded well to our water-cooling system, providing a decent overclock and earth-shattering benchmark scores. Without a doubt, the FX-57 is the gaming choice . . . until something better comes along.

Processor: AMD Athlon 64 FX-57
Motherboard: ASUS A8N-SLI Deluxe
BIOS Mfr/Rev: ASUS 1012.003 Beta
Video Driver: NVIDIA 77.72

Settings

FSB (MHz)	Multiplier	Clockspeed (GHz)	Core Voltage	PCI Express Frequency	Memory Frequency	Memory Voltage	Chipset Voltage	Spread Spectrum
200	14	2.8	1.4V	100MHz	400MHz	Auto	N/A	Disabled
220	14	3.08	1.55V	100MHz	400MHz	2.8V	N/A	Disabled

Benchmarks

3DMark05	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	Doom 3 (FPS) 1st/2nd Run	Half-Life 2 (FPS)
10183	5167	5185	4418	7644	8645	84.7 (109.2)	98.02
10744	5729	5783	5364	7876	8520	95.2 (123)	111.97

the other drivers) and several clean Windows installations.

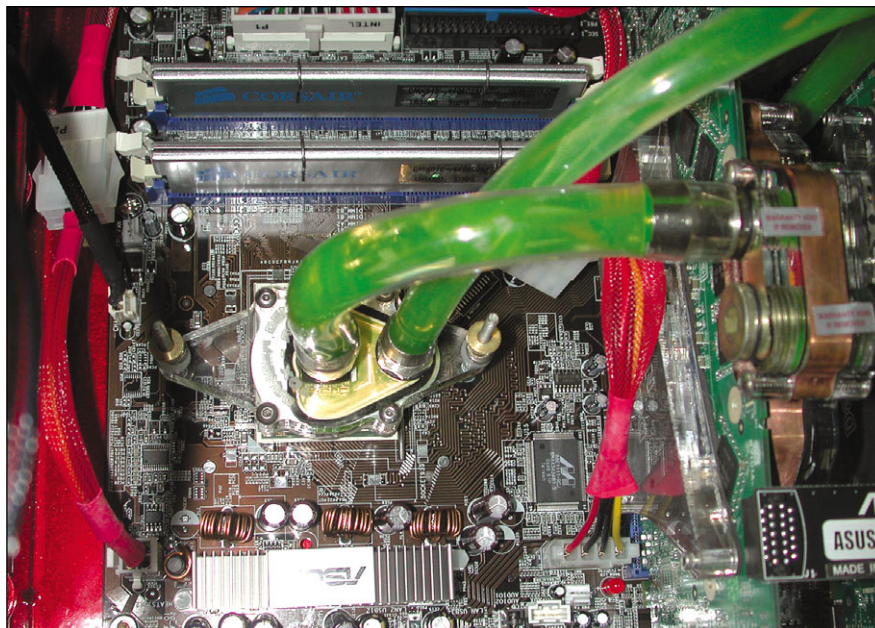
We suspected that the secondary video card was bad, so we removed it from the system and tested it in a test SLI rig. Sure enough, the card displayed a distorted picture for a few minutes before dying altogether. We bit the voided-warranty bullet and ordered a new BFG GeForce 6800 Ultra, verified that it had the right BIOS, and then attempted to reattach it to the video card waterblock. The poor connector tube couldn't handle the stress and leaked again, much more quickly than it had before.

We couldn't stop this leak, so we quickly detached the cards and then drained the entire watercooling system. After we flushed out the tubes, we cut a short tube, dipped the entire tube in hot water for a minute, and then popped it over the graphics card waterblock connectors. Finally, we had an airtight seal that could handle the stress we put on it. We reinstalled the cards and then refilled the reservoir with MCT-5. The new connector tube didn't leak a drop. If you buy the NV-68SLI kit, we recommend ditching the connector tube and using the hot water method to create a strong seal.

Unfortunately, we ran into the same problems as soon as we restarted our computer. Again we tried legacy drivers, phone calls to tech support, and clean Windows installations. We considered using ASUS' beta BIOS version, but we had read some scathing reports of instability problems online. Around 3 a.m. one fine Sunday morning, our intrepid tech, Luke Pawlowski, convinced us to give the beta, 1012.003, a shot. We flashed the new BIOS, started the computer, and cheered when the rig recognized both video cards and chewed through 3DMark05, with a whopping score of 10183.

Overclocking Madness

Although the Stingray produced great frame rates in Doom 3 and Half-Life 2, it didn't break any records with its PCMark04 score of 5167. That's not a



The Tygon tubing has much thicker walls than the less expensive tubing you'll find at local hardware stores. We like it because it's kink-resistant and slides on easily (when hot).

bad score, but it proves that this processor makes a better gamer than office part. On the gaming side of the chart, however, our rig was positively smoking. We jumped into the BIOS and pumped up the volume to 3GHz. Next, we switched the PEG Link Mode field to Faster (this increased memory performance) and then ran the benchmarks again. This time the Stingray produced a 10589 in 3DMark05, a 5483 in PCMark04, and solid frame rates in both Doom 3 (89.2fps on the first run, 115.5fps on the second run) and Half-Life 2 (104.19fps).

We used a similar setup when we ran the "Race For The Gold" competition (see page 98), but we expected better results. (After all, those graphics card waterblocks and extra 1GB of graphics memory had to count for something.) And although the Stingray couldn't top that rig's best clock speed (they tied at 3.08GHz), the Stingray pounded its way to the lead in the benchmarks. With its vcore maxed out at 1.55V and its DDR voltage at 2.8V, the Stingray system posted a final 3DMark05 score of no less than 10744. It also screamed through Doom 3 with a first-run frame rate of 95.2fps and a second-run frame rate of 123fps. In

Half-Life 2 it posted a frame rate of 111.97fps.

Try as we might, we couldn't push the Stingray past 3.08GHz. It crashed during benchmarking when we lowered and raised the multiplier, so we stuck to the frequency and raised the voltage, but the CPU wouldn't budge from 3.08GHz. Although we've seen larger overclocks from other processors, we've never seen performance at this level, so we're not complaining.

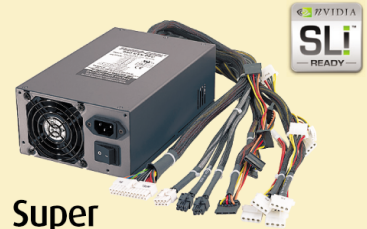
Hard-Won Victory

After weeks of struggle, we, er, Pawlowski finally dug up the fix to our Stingray's graphics woes. We tested the system right up until the day before we went to press, then submitted the text to some extremely agitated editors. Ah, we love the smell of benchmarks in the morning. This rig is too cool to sit on a desk, so keep an eye out for it at your next local LAN party. If you ask nicely, you might just get to take it for a spin.

No, you cannot touch the watercooling system. **CPU**

by Joshua Gulick

Heavyweight Champ.



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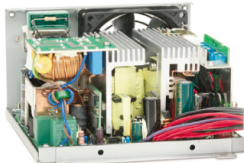
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Race For The Gold

Intel & AMD Square Off Once Again

History has a multitude of examples of well-known rivalries, such as Spartans and Athenians, the Hatfields and McCoys, and Yankees and Red Sox. In the world of computing, however, no rivalry sparks more flame wars than the Intel vs. AMD debate.

With each new processor, the stakes are raised and the battle intensifies, lawsuits are filed, fairly perplexing naming conventions are scrapped and replaced with even more incomprehensible ones. All the while, the impartial consumer gets faster and faster CPUs. (Well, we're mostly impartial.)

As with all great rivalries, though, the battle for your desktop won't be decided in court, but in the real world. We over-clocked the best that AMD and Intel have to offer in an all-out, go-for-the-gold battle-royale that can only end in tears of neon-green coolant for the loser and the well-earned (but figurative) laurels of triumph for the winner.

AMD. As we were building and testing our systems, AMD's latest enthusiast chip, the Athlon 64 FX-57, hadn't shipped yet, but AMD sent us this 939-pin powerhouse via armored courier and a police escort. A lot has changed for AMD's FX line of processors since the last "Race For The Gold" (*PC Modder V2.0*). The Athlon 64 FX-55 we used back then was still based on the 130nm manufacturing process, shared by other Sledgehammer-core CPUs, such as the Athlon 64 4000+ and the Athlon 64 FX-53.

The Athlon 64 FX-57 we're using this time around is based on the San Diego core and the newer 90nm process, which packs 114 million transistors onto the die. The FX-55 with its 130nm process

only boasted 105.9 million transistors. A few of the San Diego core's highlights include 1MB of L2 cache, a 115mm² form factor, and a 1.4V nominal voltage. The new core adds SSE3 instructions to the existing SSE2, SSE, MMX, and 3DNow! instructions.

Just when you thought AMD had mined all the clock speed they could from the Athlon 64s, they went ahead

chose to leave out DDR2 support with this core revision, though that was probably to preserve the Athlon 64 FX's 939 pin count.

Although Intel has given AMD a bit of a thrashing in past "Race For The Gold" articles, we expect the FX-57 to perform well in single threaded applications and games. If you're interested in purchasing AMD's flagship, though, make sure your piggy bank is sufficiently porky before you send it to slaughter for one of these babies. As we went to press, we found the AMD Athlon 64 FX-57 and heatsink package selling for \$1,109.

Intel. In the blue corner, Intel's latest, greatest offering comes in the shape of the Pentium 840 Extreme Edition. In the previous outing, Intel's 3.4GHz Pentium 4 Extreme Edition showed well across the board against the Athlon 64 FX-55. Like AMD's best processor at the time, the



The Swiftech MCW6000 provides large 3/8-inch diameter fittings to move large volumes of water over the processor. Aaah, cool and refreshing.

and added another 200MHz to the Athlon 64 FX-57, for a total of 2.8GHz. The FX-57 also comes with a revamped memory controller that features improved memory mapping and loading and even lets you install different sized DIMMs on the same channel. AMD

3.4GHz P4 EE was also built using the 130nm manufacturing process.

The Pentium 840 EE includes two standard Prescott cores integrated on a single die. Both cores include their own 1MB of L2 cache and are created using Intel's 90nm fabrication. If smaller transistors

mean faster, more efficient, and cooler processors, then the Pentium 840 EE should be one coolly efficient processor, right? Not so fast. Intel has had energy and heat problems with Prescott from the beginning. (Heat leaks from smaller transistors more easily.) Because the Pentium 840 EE's Smithfield core actually consists of two identical Prescott-like cores, the chip's 230 million transistors consume twice the energy and churn out twice the heat of a single-core Prescott.

To compensate for the heat problem, Intel bit the bullet and equipped the EE 840 with a 3.2GHz clock and an 800MHz FSB. You'll also find Intel's Extended Memory 64 Technology (EM64T) on this chip, which supports both 32-bit and 64-bit applications. EM64T also lets your system address more than 4GB of both physical and virtual memory. Intel also threw in the Execute Disable Bit capability, which can help to prevent worms and buffer overflow attacks.

In the dual-core world, Intel's Extreme Edition moniker denotes Hyper-Threading, a feature lacking from Intel's standard Pentium D processors. That means the Pentium 840 EE is capable of processing as many as four threads simultaneously.

This dual-core Hyper-Threading-enabled beast eats multithreaded applications for breakfast, so we expect some good numbers in PCMark04's overall and CPU benchmarks. Support for DDR2 should also provide an assist in PCMark04 Memory scores. Never mind multithreaded applications, the Pentium 840 EE will also do a number on your wallet: We found Intel's dual-core Pentium 3.2GHz Extreme Edition 840 for \$1,012. True, you are getting two processors for the price of one, but considering Intel's 3.2GHz Pentium 4 640 sells for approximately \$250, this isn't exactly a bargain. The problem is with Intel's yields. The current dual-core manufacturing process requires Intel to throw away both cores if just one is bad.

Testing Systems & Methodology

As always, it's a good idea to form a plan of action before starting any endeavor.



The AMD system's CPU waterblock had plenty of breathing room on all sides. Wish we could say the same for the chipset waterblock.

That way you can watch your plan get torn to shreds as events unfold. Our original plan was to run each of our respective processors on three motherboards using the same hardware we used for case studies. We'd then choose the board that we thought would offer the best performance and placed it in an Asetek watercooling system along with a GeForce 6800 Ultra (two if the board supported SLI) and a RAID 0 array. As you'll see, we ran into a few problems along the way and had to shift our approach a bit.

We used PCMark04 and 3DMark05 in both our initial and final testing. PCMark04 is a synthetic benchmark that returns an overall performance score along with individual component scores for the processor, memory, video card, and hard drive. 3DMark05 is an application benchmark that measures system performance by running video game simulations along with several other multimedia intensive tasks. Finally, we used Doom 3 and Half-Life 2 timedemos as real-world benchmarks. We ran the default Doom 3 timedemo in High Quality 1,280 x 1,024 resolution with 2X antialiasing. Half-Life 2 lacks a default timedemo, so we recorded our

own demo and ran it at 1,280 x 1,024 with Model and Texture levels set to high. We also enabled 2X antialiasing and 2X anisotropic.

After recording our baseline scores, we increased the FSB and ran 3DMark05 to test performance and stability. Once we found the highest stable FSB speed, we ran PCMark04, Doom 3, and Half-Life 2 to get a better idea of our performance gains. If the system included an unlocked multiplier, we reset the FSB to its default value and incrementally increased the multiplier using 3DMark05 to test performance and stability. Once again, we ran PCMark04, Doom 3, and Half-Life 2 at the highest stable multiplier. Finally, we increased both the FSB and the multiplier in order to find the best possible performance.

Intel Pentium 4 840 Extreme Edition & ASUS P5ND2-SLI

We couldn't wait to see what Intel's high-end, dual-core processor was capable of. We started testing the processor on an ASUS P5ND2-SLI. The P5ND2-SLI uses NVIDIA's nForce4 SLI Intel Edition on the northbridge and an NVIDIA MCP04 on the southbridge. Next, we

tested the P4 840 EE with the Intel 955X-based ASUS P5WD2 Premium and Gigabyte GA-8I955X Royal.

Before beginning our testing on the P5ND2-SLI, we installed BIOS update 0802 from the ASUS Web site. Even after the upgrade, however, we noticed that the board was running our 3.2GHz Pentium 840 EE at just 2.8GHz. Looking into the issue, we discovered the processor's multiplier was set to 14X instead of 16X. Playing with the multiplier, we found the BIOS was capable of setting the multiplier as high as 60X. The P5WD2 also featured an unlocked multiplier as did the Gigabyte GA-8I955X. None of the boards used the proper multiplier by default forcing us to set the processor's multiplier manually before testing.

Our best score on the P5ND2-SLI was a 3687 3DMark05 and a 7011 PCMark04 score with a FSB of 213MHz and a multiplier of 18X. The P5WD2 Premium posted its best scores with the FSB cranked up to 278MHz. While this was the best FSB speed we achieved on any of the three boards, we had to reduce the processor's multiplier to 14X in order to achieve it. As a result, the processor was only running at 3.89GHz. With these settings the P5WD2 posted some impressive

P5ND2-SLI may not have posted the best score, but it was the only board to officially support SLI. (The P5WD2 has a second PCI-E X16 slot, but it's utilized for dual monitor displays, not SLI.) It was pretty obvious to us that SLI would provide a significant increase beyond that which we might see from overclocking alone. So in the end we opted for the ASUS P5ND2-SLI even though it yielded some of the lowest performance scores in our initial testing.

We configured our watercooling system using a Swiftech MCW6000 CPU waterblock specifically designed for our LGA 775 socket. After securing the watercooling system in place, we tested our motherboard at stock speeds only to eventually scrap our initial scores. As soon as we tried to overclock our FSB, our SLI configuration came to a catastrophic halt. Frame rates absolutely plummeted in 3DMark05. In the initial 3DMark05 test, we saw frame rates around 45fps. After increasing the FSB, frame rates dropped to around 17fps.

We checked again for a BIOS update that might solve the problem and noticed the 0802 update we installed previously was no longer available online. So, we reverted back to the 0708 revision. When

puzzling. Our overall PCMark04 score was a disappointing 5953. (Our stock score on the air-cooled system was 6222.) RAID, evidently, made little difference, at least initially, as we posted a disappointing 4935 HDD score. All other scores, however, improved dramatically. Our CPU score increased from 5780 to 6835, and our Graphics score increased from 4399 to 7436. We didn't expect our Memory score to increase much, but we did see a decent improvement from 5257 to 5692.

With air cooling, we managed to increase the FSB to 940MHz. There's no point starting below that, so we jacked the FSB up to 940MHz. When we tested the air-cooled system, we had to increase our memory, chipset, southbridge, CPU Termination, and CPU voltages in order to get our system stable. In the water-cooled system, however, we were able to leave all our voltages at their default levels. The increase was dramatic. Our 3DMark05 scores shot up to 8317.

When we increased the FSB to 980MHz, we got a blue screen right after Windows finished loading, so we stabilized the system by increasing the CPU voltage by 100mv yielding an 8417 3DMark05 score.

Intel

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	3.2GHz	200MHz	16	Auto	5953	6835	5692	7436	4935	7462	65.4fps	70.16fps
Overclocked Performance	3.92GHz	245MHz	16	Auto	6782	7252	6175	7511	5485	8470	74.1fps	81.90fps

scores including a 3702 3DMark05 score and a 7374 PCMark04 score. The Gigabyte GA-8I955X Royal's multiplier setting only went up to 16X, but we still managed to get the FSB up to 250MHz resulting in 4.00GHz processor. At this speed we posted an impressive 3712 3DMark05 score, but our PCMark04 scores were abysmal (5402 overall). The GA-8I955X also posted the best Doom 3 and Half-Life 2 scores.

When it came time to pick the motherboard, however, we had more than performance scores to consider. The ASUS

the BIOS revision failed, we tried older video drivers but without much success. Finally, we installed En Tech's PowerStrip (www.entechtaiwan.net/util/ps.shtm), which seemed to resolve the problem, at least at first. However, due to the BIOS revision, our previous scores were useless, and we had to return to stock speeds and retest the system.

As expected, our 3DMark05 scores soared to 7462 with SLI enabled. Doom 3 and Half-Life 2 scores also increased dramatically to 65.4fps and 70.16fps, respectively. PCMark04 scores were a bit

We tried increasing the FSB to 1,000MHz, but at this speed our SLI problems returned. We tried reducing our FSB, but even at default speeds, our 3DMark05 tests were extremely slow. We uninstalled and reinstalled PowerStrip at our default settings. We then increased the FSB to 980MHz, and our 3DMark05 frame rates recovered. We ran PCMark04 and both games to make sure we had some solid scores.

After running our benchmarks, we increased the FSB, and once again, SLI gave out on us. This time we were unable

to get SLI performing as it should. We had a decent overclock, but we felt like we could've gotten more from the system than we did.

In the end we managed to increase our FSB to 980MHz, which put our processor clock speed at 3.92GHz, just shy of 4GHz. At this speed our overall PCMark04 score increased dramatically to 6782 thanks in part to a 7252 CPU score. Our Memory score increased to 6125, and our Graphics score increased to 7511. This time around we saw a more respectable HDD score of 5485. Doom 3 frame rates clocked in at an impressive 74.1fps, and Half-Life 2 performed well at 81.90fps.

AMD Athlon 64 FX-57 & ASUS A8N-SLI Deluxe

To show off what the Athlon 64 FX-57 was really capable of, we needed a very capable motherboard. It was our initial intention to use the Athlon 64 FX-57 to methodically test the top three motherboards from our Case Studies and choose the motherboard that would give us the best chance at taking the "Race For The Gold" crown.

DFI's LANPARTY nF4 SLI-DR, MSI's K8N Neo4/SLI Platinum, and the A8V-E Deluxe from ASUS all took top spots in our previous tests. The MSI and ASUS board both scored well with the Athlon 64 FX-55, while the DFI board scored well using the Athlon 64 3800+. Because the Athlon 64 FX-57

wasn't available when we tested the boards, we relied on the Athlon 64 FX-55's scores, and retested the DFI board using that processor.

As a side note, we typically like to include a strong performer from each of the three chipsets tested in the Case Studies, but ATI's Radeon XPRESS 200 chipset just couldn't cut it when compared to the nForce4 SLI and the K8T890 chipsets. As a result we chose two nForce 4 SLI motherboards. To be fair, the Radeon Xpress 200 was designed as an integrated graphics platform rather than an enthusiast chipset.

Once we had the overclocked scores from all three boards using air cooling, we settled on the DFI LANPARTY nF4 SLI-DR due to its superior scores. We also favored the NVIDIA chipset because we wanted to see how well AMD's SLI setup would perform against the fledgling Intel version. Next we turned our attention to the watercooling system, but quickly realized that the LANPARTY nF4 SLI-DR was not built with watercooling in mind.

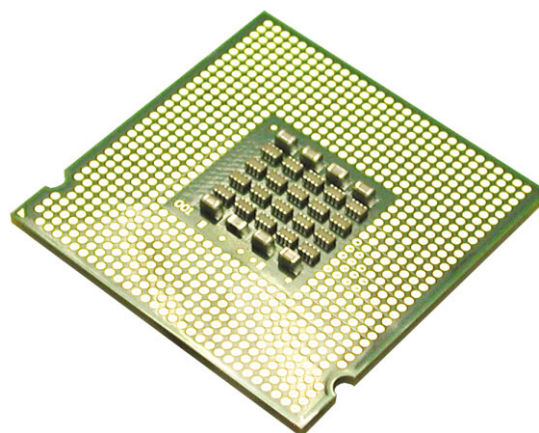
DFI situated a single x1 PCI-E slot between the board's two PCI-E x16 slots, which puts the nForce4 SLI chipset directly beneath the extra-long GeForce 6800 Ultra cards. The chipset waterblock from the Asetek WaterChill watercooling kit features two 7/8-inch diameter stems (one intake and one outtake), which wouldn't fit past the 6800 Ultra's rather bulky heatsink. The MSI board also featured the

System Specs

Processor, Motherboard & Drivers	
Processor	Intel Pentium 840 Extreme Edition
Motherboard	ASUS P5ND2-SLI Deluxe
BIOS	
Manufacturer	American Megatrends
BIOS Version	0708
Chipset Driver	NVIDIA 7.13
Graphics Driver	71.89
RAM	2 x Corsair XMS 512MB DDR2-800
Common Components	
Video	2 x AOpen Aeolus 6800Ultras
Hard Drive	2 x Maxtor 160GB 7,200rpm HDDs in RAID 0 array
Watercooling	Asetek WaterChill kit, Swiftech MCW6000 CPU Waterblock
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Coolermaster Wave Master TAC-T01-E1C

same PCI-E slot proximity problem. We pulled out every AMD-based, SLI-capable motherboard we had in stock and found that almost every one suffered from the same design oversight. Only the ASUS A8N-SLI Deluxe features PCI-E slots well clear of the nForce4 SLI chipset. We also ditched the clunky Asetek chipset waterblock for a Lilliputian-sized Danger Den Maze4 chipset cooler.

With that problem averted, we strode confidently onward and ran into a whole series of new problems. The universal CPU waterblock that came with our Asetek watercooling kit showed hairline cracks at



Each of the two cores included on Intel's Pentium 840 Extreme Edition supports Hyper-Threading. As a result, The Pentium 840 EE can process four threads simultaneously.

the base of the fittings, which proved very leaky in our dry run (pardon the pun). As a result we purchased a Danger Den TDX-A64 waterblock as a replacement.

Another problem that cropped up after we decided to opt for alternative CPU and chipset waterblocks was that our pump and radiator set from the Asetek kit featured fittings for 3/8-inch ID (inner diameter) tubing, while the Danger Den waterblocks required 1/2-inch ID tubing. We got around this obstacle by heating the 3/8-inch ID tubing with hot water and forcing them over the wider fittings of our waterblocks; the result of which was an ultra-tight fit and just a little wrist pain.

AMD's San Diego core still does not support DDR2 memory, so we equipped the AMD system with the same two 512MB sticks of ultra-low latency Corsair XMS PC-3200 memory used in the Case Studies. Next we configured our RAID 0 array, installed Windows, and then loaded the latest motherboard and video drivers. We also made sure we had the latest BIOS from ASUS (version 1011). Once we had the games and benchmarks loaded, we ran them all using the motherboard's Optimized Defaults.

With the SLI option enabled in the settings, we achieved a stunning 10125 in 3DMark05. Doom 3 and Half-Life 2 also posted impressive scores with 83.1fps and

4000+ for the Case Studies, so we knew that PEG Link Mode set to Faster would give us a decent boost. We also set the Multiplier from Auto to 14 and raised the CPU Voltage from Auto to 1.55V. Due to the significant difference between the Athlon 64 4000+'s Sledgehammer core and the FX-57's San Diego core, we chose to start adjusting the CPU Frequency from the ground up. We raised the CPU



AMD's flagship Athlon 64 FX-57 packs some serious horsepower underneath its heatspreader.

Frequency from 200MHz to 210MHz, restarted our system, and ran 3DMark05. Our score improved by 277 points to 10402.

rebooted. We tried successively lower frequencies, but 3DMark05 kept freezing before it would complete. We tweaked various settings, including DDR Voltage, PCI Clock Synchronization Mode, DRAM Timing Mode, Memclock Index Value, CAS Latency, and Hyper-Transport Frequency, but nothing would let us lift the CPU frequency above 220MHz.

With the Athlon 64 FX-57's Frequency at 220MHz and the multiplier at 14, our effective clock speed was 3.08GHz. Using this clock speed as a guidepost, we started adjusting the Athlon 64 FX-57's multiplier from its native 14. We lowered the multiplier to 12 and 13 and raised the CPU Frequency to 257MHz and 238MHz respectively, but the system wasn't stable enough at either setting to post scores. Next we tried leaving the CPU Frequency alone and raising the multiplier to 15, which resulted in a 10425 3DMark05 score. We tried the default CPU Frequency at a 15.5 multiplier, but 3DMark froze midtest.

We achieved our best scores after we had set the CAS Latency to 2.0, changed the DRAM Voltage to 2.75V, and set the CPU Frequency and CPU Multiplier to 220MHz and 14, respectively. We had also set the PEG Link Mode to Faster, raised the CPU Voltage to 1.55V, and adjusted the

AMD

	Processor Speed	FSB	Multiplier	Voltage	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD	3DMark05	Doom 3	Half-Life 2
Stock Performance	2.8GHz	200MHz	14	Auto	5188	5262	5016	7647	5665	10125	83.1fps	104.91fps
Overclocked Performance	3.08GHz	220MHz	14	1.55	5711	5791	5419	7867	5669	10506	88.4fps	112.34fps

104.91fps, respectively. The single-threaded Athlon 64 FX-57 didn't perform as well in PCMark04, managing a 5188 overall rating. The Graphics score was, not surprisingly, the best of the lot at 7647. The CPU, Memory, and HDD scores were 5262, 5016, and 5665, respectively.

We had already overclocked the ASUS A8N-SLI Deluxe and the Athlon 64

Back in the CMOS Setup Utility, we raised the CPU Frequency to 220MHz, pressed F10 to save our changes, and then pressed ENTER to reboot. This time we managed to score 10468 in 3DMark05. We went back into the CMOS Setup Utility and raised the CPU Frequency to 225MHz, but this time we got the Blue Screen of Death just before Windows

Memclock Index Value to 400MHz. We also noticed a minor 3DMark05 boost with the PCI Express Clock set to 105MHz, but anything more resulted in an unstable system.

Our overclocked AMD-based system posted a 10506 in 3DMark05, 88.4fps in Doom 3, and 112.34fps in Half-Life 2. Again the PCMark04 scores were a bit of a

letdown: The system managed only 5711 in the overall test. The CPU, Memory, and HDD scores were 5791, 5419, and 5669 respectively. Our Graphics score of 7867 was the one notable number of the bunch.

Conclusion

In the past AMD has had trouble keeping up with Intel, at least in our “Race For The Gold” series. This time around, however, AMD looked like Lance Armstrong strolling through the French Alps without a care, or competitor, in sight. The Athlon 64 FX-57 absolutely smoked the Intel Pentium 840 Extreme Edition.

At first it looked like Intel might grab the title again judging from its PCMark04 scores. The Pentium 840 EE’s 5953 overall PCMark04 score was nearly 750 points better than the FX-57’s score, and the Pentium 840 EE enjoyed a 1573 point higher CPU score thanks to its multithreading capabilities. AMD, however, did enjoy some advantages when it came to Graphics and HDD performance. The AMD system managed a 185 point higher Graphics score and a 730 point higher HDD score. Still, things looked good for the Pentium 840 EE until we compared

3DMark05 scores. We thought the 7462 posted by Intel seemed pretty good until we saw the 10125 score posted by the FX-57. Things only got worse when we compared Doom 3 and Half-Life 2 frame rates. The FX-57 outpaced the Pentium 840 EE by 17.7fps in Doom 3 and 34.75fps in Half-Life 2.

The Pentium 840 EE overclocked further than the FX-57, allowing Intel to close the 3DMark05 performance gap a bit. With both processors overclocked, the Pentium 840 EE managed to cut the FX-57’s 3DMark05 advantage from 2663 to 2036. Six hundred points is a lot of ground to cover, but Intel still had a long way to go. As we said, we think we could’ve gotten more from the processor had our SLI subsystem proved more stable, but there’s no way Intel could’ve found another 2000 points in 3DMark05.

Intel continued to do well in PCMark04. When overclocked, Intel expanded its overall PCMark04 advantage from 750 points to 1071 points. AMD managed to gain ground in PCMark04’s CPU test cutting Intel’s advantage from 1573 points to 1461 points. The higher frequencies supported by DDR2 provided an advantage for Intel throughout our testing.

System Specs

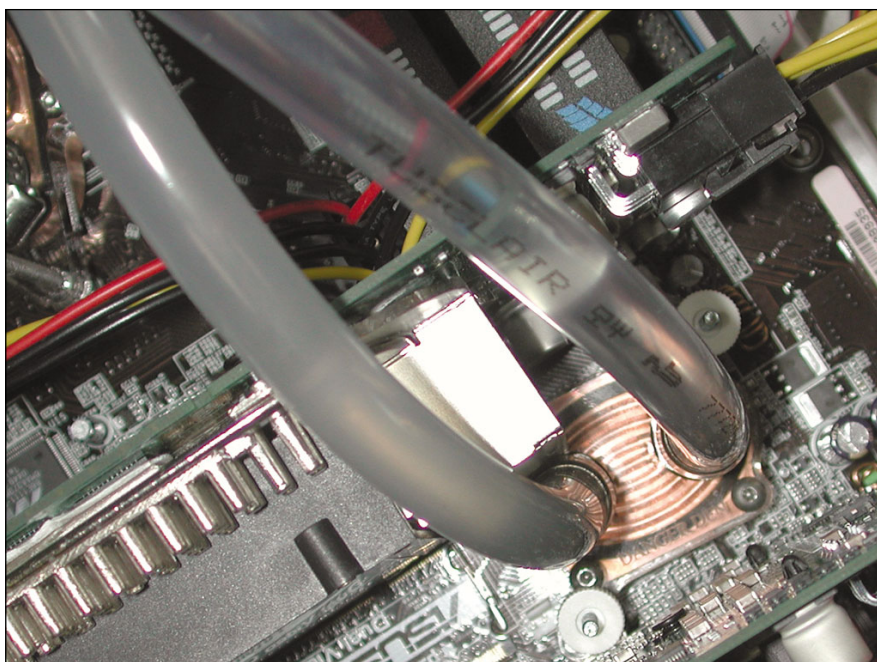
Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 FX-57
Motherboard	ASUS A8N-SLI Deluxe
BIOS	
Manufacturer	Phoenix Award
BIOS Version	Version 1011
Chipset Driver	NVIDIA chipset driver version 6.66
Graphics Driver	NVIDIA ForceWare 77.72
RAM	1GB (512x2) Corsair XMS Xpert Dual Channel Kit 184-pin PC-3200
Common Components	
Video	2 X Gigabyte 256MB GeForce 6800 Ultras
Hard Drive	Two Maxtor 160GB 7,200rpm HDDs in RAID 0 array
Watercooling	Asetek WaterChill kit, Danger Den TDX-A64 CPU waterblock, and Danger Den Maze4 chipset waterblock
Optical Drive	Pioneer 107D DVD±RW
Floppy	Mitsumi 1.44MB Floppy
Power Supply	550W Antec TruePower II-550
Case	Coolermaster Wave Master TAC-T01-E1C

Intel’s initial 273-point Memory advantage increased to 756 points by the time we were finished overclocking both boards. AMD, however, maintained an edge in PCMark04 Graphics and HDD tests. When overclocked, AMD’s Graphics advantage grew from 211 points to 356 points. Intel posted a much improved HDD score when OCed and, as a result, cut the HDD advantage for AMD from 730 points to 184 points.

A few PCMark04 victories, however, are a pretty lame consolation prize for Intel, especially in light of its Doom 3 and Half-Life 2 frame rates. Intel did close the gap a bit but not nearly enough. AMD’s Doom 3 advantage dropped from 17.7fps to 14.3fps, and its Half-Life 2 advantage fell from 34.75fps to 30.44fps.

Obviously, we had some SLI problems on the Intel system, but this can’t entirely explain the advantages AMD enjoyed in our testing. True, Intel did well in PCMark04, but who really cares? After all, which would you rather brag about, PCMark04 scores or an extra 30 to 35fps in Half-Life 2? AMD soundly beat Intel, and for the first time in *PC Modder’s* brief but proud history, takes home the gold. **CPU**

by Andrew Leibman and Chad Denton



In our AMD system, even the tiny Maze4 chipset waterblock barely scraped past the NVIDIA GeForce 6800 Ultra’s giant heatsink.

Graphics Bus Deathmatch

Does PCI-E Really Make A Difference?

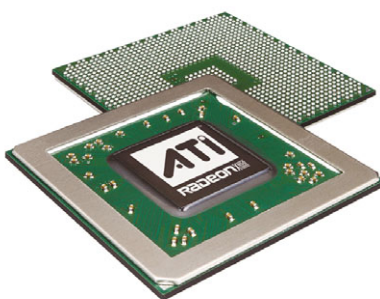
If Rand McNally ever took up the task of mapping out the myriad upgrade paths for power users, it would probably run out paper. As new technologies emerge on a daily basis, upgrading to achieve “the perfect rig” is essentially a fool’s errand. If it isn’t time for a new processor or motherboard, there’s always that phase-change cooling system tempting you and your pocketbook.

But that doesn’t mean taking a piecemeal approach to improving your hardware isn’t a sound idea. In fact, upgrading certain equipment can lead to massive performance improvements in certain applications, such as buying a better video card for 3D games. If possible, buying a single component is a cheaper alternative than an entire system. It’s usually a smarter choice, too.

There are some circumstances when upgrading a single component requires you to simultaneously upgrade other components. For example, when Intel introduced its 915 chipset, a new processor socket (the LGA775) also appeared. With a few exceptions, anyone with an Intel 875 chipset-based motherboard also used a 478-pin Intel CPU. Almost every single Intel 915-based motherboard required a Socket 775 processor; if you wanted the latest Intel chipset on your motherboard, you’d have to scrap your processor, too. If that wasn’t bad enough, most 915-based boards also required 240-pin DDR2 RAM instead of 184-pin DDR RAM 875-based mobos preferred. All of a sudden, that motherboard upgrade has you shopping for a new CPU and memory.

For example, let’s say you snagged a Socket 939 motherboard and an AMD Athlon 64 FX-53 processor but ran out of cash to upgrade your ATI Radeon 9600XT

graphics card. Now that you want to upgrade your graphics card, you’ve found that your motherboard uses an AGP graphics bus. Although you can still buy top-end AGP graphics cards, is the PCI Express bus superior? Should you just bite the bullet



ATI X850 VPUs for your viewing pleasure.

and purchase a new motherboard with a PCI-E x16 graphics slot?

Because manufacturers are still doing a commendable job of making graphics cards with the same GPU/VPU for either the AGP or PCI-E x16 bus, is one bus superior to another? We rounded up some of the best graphics cards that are available in both AGP and PCI-E flavors to settle this graphics grudge.

How We Tested

When we set out to test the AGP and PCI-E buses, we wanted to keep as much of our hardware the same as possible. Obviously, it doesn’t make much sense to set up a test environment using an Intel 875-based motherboard with an AGP slot against an Intel 915-based motherboard with a PCI-E x16 slot. At the very least, we would have had to use two different processors and different sets of RAM.

Our ideal testing conditions would have included a motherboard with VIA’s PT880 Pro chipset. This chipset supports an AGP and PCI-E graphics bus, so the only component we would have needed to change in our test system would have been the graphics cards themselves. Unfortunately, VIA PT880 Pro-based motherboards were barely starting to trickle onto retail shelves at press time, so we went with the best possible alternative.

We settled on two motherboards with different chipsets. For our AGP cards, we tapped Epox’s 9NDA3, which uses an NVIDIA nForce3 Ultra chipset; we used ASUS’s A8N SLI Deluxe, which sports NVIDIA’s nForce4 SLI chipset, when we tested our PCI-E cards. Although the Epox mobo uses a slightly older NVIDIA chipset, it was a Socket 939 motherboard with 184-pin DIMM slots, so we were able to keep every other component identical. We used a 2.4GHz AMD Athlon 64 FX-53 processor with 1GB OCZ PC4400 RAM. Our other system specs consisted of the following hardware: a 7,200rpm, 160GB Maxtor DiamondMax Plus 9 SATA150 hard drive, a 380W Antec PSU, and Windows XP Professional SP2. For our NVIDIA graphics cards, we used the ForceWare 77.72 driver (released June 22, 2005), and our ATI graphics cards chugged along with the Catalyst 5.6 driver (released June 9, 2005).

After we assembled our test machines, we let our video cards explore the room with some punishing graphics tests, starting with 3DMark05 Build 1.2.0. We also ran time demos of the following games: Doom 3, Far Cry, Half-Life 2, and Unreal Tournament 2004. Our cards could easily handle any of these games with lower quality settings, but we used 4X antialiasing and 8X anisotropic filtering with a 1,600 x 1,200 resolution to put each card under considerable strain. After benchmarking the cards at their default settings, we added more “cowbell” to the equation by boosting each card’s core clock and memory clock speeds. For our ATI cards, we used ATI Tray Tools. We made our NVIDIA graphics cards a little spicier with Coolbits, which is a registry tweak for NVIDIA’s graphics card settings.

Accelerated Graphics, Please

When the trusty AGP (Accelerated Graphics Port) hit the scene, it made quite a splash over the then-reigning bus of choice, PCI (Peripheral Component Interconnect). PCI itself was a pretty big improvement, but as a shared bus, a PCI graphics card had to compete with any other add-on cards plugged into other PCI slots for bandwidth. The AGP took a graphics-only approach, dedicating all its bandwidth to the graphics card. Plus AGP delivered far more available bandwidth, making it superior to PCI even if a PCI graphics card was the only component using the PCI bus.

With one exception, the same manufacturer supplied both AGP and PCI-E versions of a particular VPU/GPU. Because we already had AGP and PCI-E Radeon X800 XT graphics cards sitting around in our personal gaming rigs, er, "at-home research PCs," we recycled them for this test. We used Gigabyte's GV-R80T256V, the AGP version of the X800 XT, and turned to ASUS's Extreme AX800 XT/2DT for our PCI-E X800 XT needs. Finally, Leadtek's WinFast PX6800TDH, a PCI-E GeForce 6800 graphics card, had 256MB onboard DDR; its AGP counterpart, the WinFast A400TDH, only had 128MB.

Leadtek WinFast A400TDH

Although the WinFast A400TDH had half the memory as its PCI-E twin, we thought this could provide us with insight into the amount of difference extra onboard memory made. The GeForce 6800 GPU's default core clock speed is fairly close to the GeForce 6800 GT, but its fewer pixel pipelines (12) and consequently slightly less graphics crunching muscle.

In stock tests, the A400TDH was definitely the runt of NVIDIA's litter, but it's a pretty solid card considering it's quite a bit cheaper than when it debuted over a year ago. In 3DMark05, the A400TDH scored a 3545, 1360 3DMarks off the pace the eVGA

GF 6800 GT set, and 211 3DMarks behind the PX6800TDH, the PCI-E GeForce 6800 graphics card.

According to our game tests, the quality settings introduced the A400TDH to a pretty healthy beatdown in every timedemo except UT 2004. At 24.6fps, 31.7fps, and 18.03fps in Doom 3, Far Cry, and Half-Life 2, respectively, you'll probably want to either reduce your resolution or antialiasing/anisotropic filtering to make these games play smoothly. We should add that the A400TDH limped through our Half-Life 2 timedemo with more artifacts than the Temple of Doom.

Despite somewhat low scores in our game tests, the A400TDH proved to be a decent overclocker. We increased the card's core clock speed by 12.6% and boosted its memory clock speed 10%. With the exception of UT 2004, our scores didn't improve by as great of a margin, but the A400TDH did show across-the-board gains.

eVGA 256-A8-N344-AX

NVIDIA's GeForce 6800 GT GPU might play second fiddle to the 6800 Ultra, but the performance difference



Sure, that battle axe looks menacing, but what about Minotaur halitosis? That's enough to put anyone off.

between the two is smaller than you might think. With a default 350MHz clock speed and 1GHz memory clock speed, 6800 GT cards trail 6800 Ultra cards by a hair, but that gap isn't as wide when you consider both the 6800 GT and 6800 Ultra have 16 pixel pipes. By overclocking a 6800 GT card, you can narrow the performance gap.

Our benchmarks seemed to corroborate this. For example, in 3DMark05, the difference between the eVGA 256-A8-N344-AX and MSI's NX6800Ultra T2D256 (634) was considerably less than between the GF 6800 GT and the WinFast A400TDH (1360). In our game tests, the

The 7800 GTX: Say Hello To My Lil' Heatsink!

One of the first things you'll probably notice about NVIDIA GeForce 6800 Ultra graphics cards is their size. They're huge. Although the heatsink and fan that keep the 6800 Ultra GPU cool were probably an essential component, they do create a number of problems for ambitious power users.

First, anyone who uses two 6800 Ultras in SLI knows that space constraints and airflow

can create real cooling problems. Many SLI-capable motherboards have the nForce4 SLI chip located close to both cards' heatsinks, and that's a lot of warmth that builds up in relatively small space. Furthermore, the sheer size of the cards can limit the number of expansion cards you can put in your case.

NVIDIA's newest graphics workhorse, the GeForce 7800 GTX, scoffs at the idea of

using a gigantic heatsink. NVIDIA is particularly proud of the design which is faster than the 6800 Ultra yet draws less power, resulting in a quieter card and a smaller, single-slot heatsink.

And calling the 7800 GTX faster is a bit of an understatement. Check out our chart for the real skinny, and when you stash enough cash to buy two of these for SLI, look out. ▲

256-A8-N344-AX also nipped at the NX6800Ultra T2D256's heels, and when you consider most 6800 GT graphics cards are less expensive, the eVGA's 6800 GT is an attractive choice. The results it turned in on Doom 3 and Far Cry were particularly impressive compared to the NX6800Ultra's results.

Blame it on a temporary case of bird flu, the side effects of too much all-you-can-eat shrimp at the Sizzler, or plain old bad juju, but the 256-A8-N344-AX crashed into a mountain when we tried to overclock it. Neither 3DMark05 nor Far Cry wanted anything to do with core and memory clock speeds that were even a few ticks beyond default settings. We'd hardly declare setting the core clock speed to 355MHz and the memory clock speed to 1.02GHz an effective overclock, but previous tests suggest that this card is a better overclocker than the numbers seem to indicate. Overall, our gains were negligible, and we actually lost ground in Far Cry.

MSI NX6800Ultra T2D256

At press time, NVIDIA had just rolled out its GeForce 7800 GTX GPU (see "The 7800 GTX: Say Hello To My Lil' Heatsink!" sidebar). So until recently, the

GeForce 6800 Ultra GPU was the granddaddy of NVIDIA family—and not your average granddaddy. We're talking about the kind of granddaddy who lives in Ozarks, kills cougars with his bare hands, and eats coal when there's no real food around.

The NX6800Ultra T2D256 easily proved its mastery over lesser 6 series cards in every test we threw at it (not that we were surprised). It posted an excellent 3DMark05 score (5539), and its 43fps in Doom 3 showed us why NVIDIA graphics cards remain the best choice for any Martian moon base vacations you're planning on taking your computer to. It edged similar ATI cards in UT 2004 but trailed slightly in Far Cry. The NX6800Ultra T2D256 couldn't match the ASUS AX850XTP (an ATI Radeon X850 XT Platinum Edition card) or the Gigabyte GV-R80T256V (an ATI Radeon X800 XT card) in Half-Life 2.

We were able to coax a little more steam out of the NX6800Ultra, pushing it to 438MHz and 1.12GHz core and memory clock speeds, respectively. With these settings our 3DMark05 score moved north from 5539 to 5695, over a 150-point increase. All of our other game

tests showed improvements, too, but the increase was so insignificant that you won't notice an appreciable difference in performance when you're actually playing one of the games. Fortunately, there are plenty of watercooling options out there for overclocking enthusiasts. Go get 'em.

Sapphire AX800PRO

We had quite a surprise in store for us when we tested Sapphire's AX800PRO. It's possible this card benefited from the Athlon 64 FX-53 processor or a driver update, but this was not the same card we tested the last time around (PC Modder v2.0). It may only have 12 pixel pipelines, but the AX800 PRO definitely made full use of each of them.

For example, the AX800 blazed through 3DMark05 with a score of 4947, topping both versions of the GeForce 6800 and nearly doing the same with the GeForce 6800 GT. In our game benchmarks, it told a similar story. With the exception of Doom 3 and UT 2004, the AX800 showed it was quite capable of going toe to toe with NVIDIA-based graphics cards.

Although the AX800 proved its merits in our stock tests, it really soared when

Get On The Bus

If you were expecting AGP to receive a thrashing at the hands of PCI Express, think again. There were a couple of quirky instances when PCI-E seemed to have the upper hand, but these were the exception instead of the rule.

	Default Core Clock	Default Memory Clock	Core Overclock	Memory Overclock	3DMark 05	Doom 3	Far Cry
AGP							
Leadtek WinFast A400TDH/Leadtek WinFast PX6800TDH	325MHz	700MHz/600MHz	366MHz/466MHz	770MHz/884MHz	3545/3756	24.6/23.2	31.7/30.33
eVGA 256-A8-N344-AX/eVGA 256-P2-N376-AX	350MHz	1GHz	355MHz/415MHz	1.02GHz/1.12GHz	4905/4991	38.3/38.2	45.37/42.4
MSI NX6800Ultra T2D256/MSI NX6800Ultra T2D256E	425MHz	1.1GHz	438MHz/441MHz	1.12GHz/1.14GHz	5539/5645	43/42.8	50.63/51.37
Sapphire AX800PRO/Sapphire RX800PRO	475MHz	900MHz	537MHz/535MHz	1.01GHz/1.07GHz	4947/4973	24.7/24.7	43.44/43.29
Gigabyte GV-R80T256V/ASUS Extreme AX800 XT/2DT	500MHz	1GHz	513MHz/535MHz	1.04GHz/1.07GHz	5837/5859	35.4/35.4	54.26/54.38
ASUS AX850XTP/ASUS EAX850XTP	540MHz	1.18GHz	562MHz/557MHz	1.23GHz/1.26GHz	6329/6393	39.4/39.7	59.93/60.18
GeForce 7800 GTX *	430MHz	1.2GHz	489MHz	1.31GHz	7606	52.9	62.38

* This is a reference card and specs are listed for your reference only.

we overlocked it. We raised the core and memory clock speeds 13% and 10%, respectively, and the AX800 treated us to some pretty fantastic scores. With 5612 3DMarks, we leapfrogged every NVIDIA-based card and came dangerously close to beating every overlocked NVIDIA-based card (with the exception of the GeForce 7800 GTX). That's scary good.

Gigabyte GV-R80T256V

Like the relationship between GeForce 6800 and 6800 GT graphics cards, one of the biggest differences between X800 PRO and X800 XT cards are those four pixel pipelines. The AX800's core and memory clock speeds reached the GV-R80T256V's default speeds when we nudged it along with our digital cattle prod (trust us, it hurts; we lost three editors before figuring out which end was the business end).

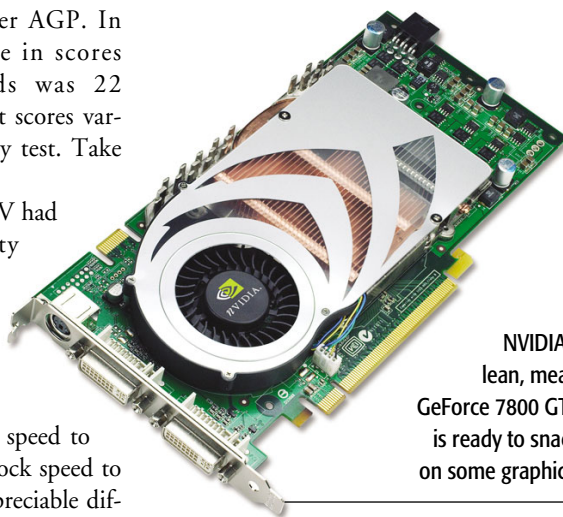
Aside from turning in some impressive numbers in all of our tests, the GV-R80T256V results, when set aside the ASUS Extreme AX800 XT/2DT (our PCI-E X800 XT), seemed to confirm our sneaking suspicion that the PCI-E bus currently doesn't offer a significant

performance advantage over AGP. In 3DMark05, the difference in scores between these two cards was 22 3DMarks, and our game test scores varied by less than 1fps in every test. Take that, PCI-E apologists.

Because the GV-R80T256V had already seen a tour of duty through another PC Modder torture test, we weren't surprised that it didn't overclock as well some of our other graphics cards. Raising the core clock speed to 513MHz and the memory clock speed to 1.04GHz didn't make an appreciable difference in our game tests, but we did cross the 6,000 threshold in 3DMark05. Even though we longed for higher speeds, we were pleased to see the GV-R80T256V chug along at a 64.4fps clip in Half-Life 2, one of the more graphically demanding games currently available (as we wait for titles based on the Unreal 3 engine).

ASUS AX850XTP

As a newcomer to our graphics deathmatch, you might consider the X850XT Platinum Edition an interim VPU from ATI. With ATI sympathizers salivating



NVIDIA's lean, mean GeForce 7800 GTX is ready to snack on some graphics.

over the future R520 chip, cards like the AX850XTP will have to satisfy your red PCB cravings for the time being. But you shouldn't be disappointed; this is a card, regardless of AGP or PCI-E preferences, with kick.

The AX850XTP did the "Kung Fu Hustle" over all of our tests except in Doom 3—and we really weren't disappointed with its performance in that game, either. It left NVIDIA's 6 series cards in the dust, particularly in Half-Life 2 (71.62fps) and 3DMark05 (6329). Granted, NVIDIA still has a slight edge with its GeForce 7800 GTX GPU, but expect a Duke/Cobra Commander grudge match (we'll let you assign respective roles) when ATI's own flavor of multirendering, CrossFire, and the R520 hit the streets.

With the AX850XTP already humming along at a 540MHz core and 1.18GHz memory clock speed, we overlocked it to a zesty 562MHz/1.23GHz, a 4% increase for both. In a few of our tests, our results were better than expected. Our Far Cry results improved by 6%, and the AX850XTP zipped through our UT2004 timedemo 19.5% faster. The AX850XTP was about 3% faster in both 3DMark05 and Half-Life 2.

The Revenge Of PCI (Express)

Poor PCI. For years, it took its lumps with lesser cards such as sound cards, NICs, and TV tuners. Meanwhile, the AGP bus enjoyed the attention of the latest and greatest graphics cards. And it didn't

Half-Life 2	UT 2004	3DMark05 OC	Doom 3 OC	Far Cry OC	Half-Life 2 OC	UT 2004 OC
18.03 (artifacts)/ 32.6	99.8/97.5	3635/5384	25.3/34.3	33.1/45.66	18.16 (artifacts)/ 25.49	129.5/34.6
43.73/44.01	135/136.7	4944/5787	38.8/44.4	42.79/51.33	44.64/51.69	144.8/152
52.07/51.37	148.6/150.7	5695/5872	44.7/44.6	51.97/50.18	53.9/53.44	151.3/154.7
51.6/50.3	93.4/95.4	5524/5612	22.5/28.6	49.08/50.51	56.75/58.83	128.2/131
65.73/65.52	110.2/110.3	6006/6173	37/37.6	56.97/50.96	64.4/71.32	136.3/138.8
71.62/72.22	119.1/120	6539/6651	41.1/41.8	63.52/56.39	74.02/78.57	142.4/145.8
81.12	167.9	8432	58.9	69.39	87.17	167.2

stop there. AGP kept improving, eventually offering bandwidth eight times greater than the original AGP. Sure, PCI made some improvements with PCI-X, but AGP remained the graphics bus of choice.

All that's different now. PCI is all grown up and has become PCI-E (but euphemisms aside, we're actually talking about different architectures). As a result, PCI-E offers more available bandwidth than AGP. The million-dollar question thus becomes: Do today's graphics cards need all that extra bandwidth?

Leadtek WinFast PX6800TDH

If we handed out awards for creepiest company mascot, Leadtek's Dissociative Identity Disorder-afflicted warlock would win hands-down. Looking pensively benevolent on the front of the A400TDH, this sorcerer's menacing visage on the front of the PX6800TDH gives us the heebie-jeebies. Creepiness aside, the PX6800TDH and A400TDH were probably two of the most dissimilar graphics cards using the same chip that we tested. Although the AGP-version's memory clock was 700MHz to the PCI-E's 600MHz, the extra 128MB memory seemed to make a difference.

We saw hints of this difference in 3DMark05, where the PX6800TDH eked out 211 more 3DMarks than the AD400TDH. However, the addition of onboard memory must have cured our problems with Half-Life 2. Not only did the artifacts vanish, our score almost doubled, leaping from 18.03fps to 32.6fps.

The PX6800TDH overclocked so well that we nearly phoned up Burt Ward to get a "Holy increased core clock speeds, Batman!" audio clip. We have to admit we were a little bewildered to see the PX6800TDH's core clock jump from 325MHz to 466MHz and its memory clock increase from 600MHz to an insane 884MHz, but numbers don't lie. These speeds may have made the card a little unstable for Half-Life 2, but the PX6800TDH steamrolled the other game tests, with a 51% increase in Far Cry leading the way. This is clearly one example of a PCI-E card outperforming its AGP counterpart.



Whether you prefer AGP or PCI-E, the X850 XT PE will rock your socks off.

eVGA 256-P2-N376-AX

The PCI-E version of the GeForce 6800GT reminded us why we liked this 6 series GPU so much. Not only is it quite a bit cheaper than 6800 Ultra cards, with a little overclocking, 6800 GT-based cards have almost as much moxie as 6800 Ultra-based cards at default settings.

The two eVGA cards put up stock numbers very similar to those from the Gigabyte GV-R80T256V and ASUS Extreme AX800 XT/2DT. The 256-P2-N376-AX had the upper hand in 3DMark05, Half-Life 2, and UT2004, but the difference was so small that you'd never notice it during actual gameplay. When the AGP 6800 GT beat the PCI-E card in Doom 3 and Far Cry, the margin of victory was .1fps and 2.97fps, respectively. Even though PCI-E will give you more bandwidth, today's games simply don't demand it yet.

Because the 256-P2-N376-AX overclocked so well, we should reiterate that we think the 256-A8-N344-AX may have been overworked from our last issue. Either way, the core clock speed improved 18.6%, and the memory clock speed climbed 12% to 1.12GHz. At those speeds, all of the 256-A8-N344-AX's scores were better than the MSI NX6800Ultra T2D256E's at its stock settings. Install a watercooling apparatus or lasso another 256-A8-N344-AX for SLI and hold on tight. You're in for a wild ride.

MSI NX6800Ultra T2D256E

We admit it's hard to get too whipped up about GeForce 6800 Ultra graphics cards now that the key players in the graphics business have GeForce 7800

GTX cards available for your enjoyment, but consider that you can probably take advantage of a nice price break (now if only we could figure out what to do with that gigantic heatsink).

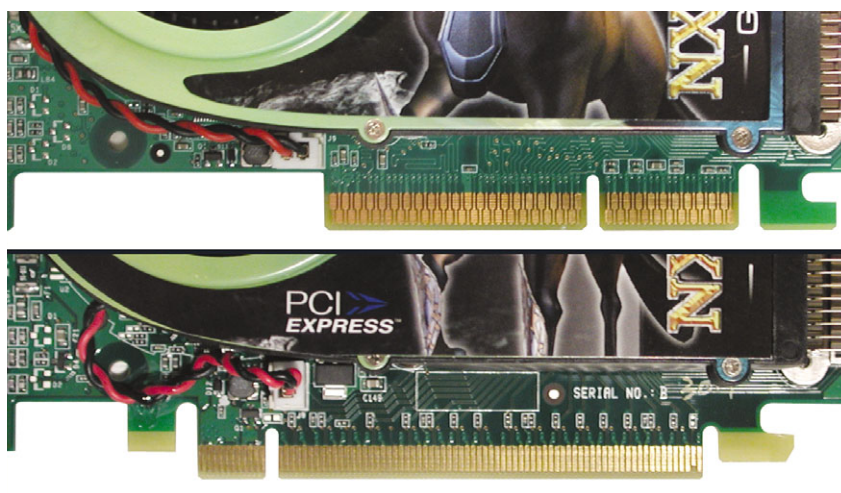
A comparison of our stock 6800 Ultra cards revealed another AGP/PCI-E slugfest that essentially ended in a draw. The NX6800Ultra T2D256E emerged from the scuffle victorious in 3DMark05 (by 106 3DMarks) and UT2004 (2.1fps), but the NX6800Ultra T2D256 had the upper hand in Doom 3 (0.2fps), Far Cry (3.1fps), and Half-Life 2 (0.7fps). At the risk of sounding like a broken record, the miniscule difference between AGP and PCI-E in today's games seems to be the rule rather than the exception. The results from MSI's two graphics cards could have easily flip-flopped at any given time.

The NX6800Ultra T2D256E responded more favorably to a modest overclock when we tested it with 3DMark05, but the improvements in our game tests were hardly something to write home about. Because the core and memory clock speeds on 6800 Ultra graphics cards are already set fairly high, the single-digit percentage increases in our tests were hardly surprising. We really can't complain too much about a graphics card that already has a considerable amount of muscle.

Sapphire RX800PRO

If Gordon Freeman, our favorite bespectacled underdog, trips your gaming trigger more than an anonymous space marine, a graphics card such as Sapphire's RX800PRO might be the solution you're looking for. It's not going to give you mind-blowing Doom 3 frame rates, but this is a great card for Half-Life 2 fans on a budget.

But that's far from saying the RX800PRO is your bargain basement graphics card. When we tested it at its stock clock speeds, it continued a trend of ATI dominance in 3DMark05, Far Cry, and Half-Life 2. The RX800PRO showed its clear superiority over Leadtek's WinFast PX6800TDH in these tests at default settings and was essentially on par with eVGA's 256-P2-N376-AX.



Pick your number of pins; for the most part, performance will be the same.

The RX800PRO also followed in the footsteps of the NVIDIA graphics cards when we compared AGP to PCI-E. As much as we would have boldly trumpeted one bus' dominance if our tests showed it, the difference between graphics cards with the same GPU/VPU was again microscopic. In 3DMark05, Doom 3, and Far Cry, the AX800PRO's and RX800PRO's scores were less than 1% apart.

The similarities continued even when we overclocked the RX800PRO. We pushed our memory clock speed a little higher on the RX800PRO, but it really didn't help us achieve remarkably better results. The RX800PRO did prove better than the AX800PRO in every test, but the difference was consistently small. We consider the 6.1fps gap in overclocked Doom 3 scores an anomaly.

ASUS Extreme AX800 XT/2DT

You have to give ASUS credit for setting itself apart from the flock of other manufacturers. Giving the Extreme AX800 XT/2DT orange PCB has a certain snazz-factor that deserves a hearty golf clap. Fire it up, and the card gives off a cool blue glow that definitely gives you a roundhouse kick to the face. Add a sweet comprehensive software bundle, and you can see why ASUS is consistently among the leaders high-performance computer hardware makers.

It seemed that different manufacturers really didn't change our scores very much. In fact, the two X800 XT graphics cards we tested probably showed the smallest performance variance across the board of any AGP/PCI-E faceoff. If you exclude our GeForce 7800 GTX test results, the X800 XT cards were second only to the speedier X850XT Platinum Edition cards. The Extreme AX800 XT/2DT and GV-R80T256V also did quite well against their peers from the NVIDIA camp in 3DMark05, Far Cry, and Half-Life 2.

Despite a hiccup in Far Cry, the Extreme AX800 XT/2DT was a better overclocker than the GV-R80T256V. Both cards' memory clock speeds were the same, but an extra 25MHz from the Extreme AX800 XT/2DT's core led us to a 5% improvement in 3DMark05 and a 9% increase in Half-Life 2. All things considered equal, we'd prefer the AX800 XT/2DT over the GV-R80T256V simply because ASUS's card produced better overclocked numbers (and there's always the oh-so-sweet orange PCB).

ASUS EAX850XTP

Arguably the Grand Poobah of ATI's current VPUs, the X850 XT Platinum Edition is quite capable of mashing 455-yard drives with little more than a 2 iron. Perhaps the best news for PCI-E X850 XT PE owners is the fact that they

won't need to scrap their cards once ATI's CrossFire Technology becomes a reality. And when you consider how good this VPU is by itself, the thought of two of these bad boys working in unison hold frightening possibilities.

You'll want an NVIDIA graphics card for Doom 3 or UT2004, but the EAX850XTP (or AX850XTP for that matter) is probably your best bet for Far Cry or Half-Life 2. All of our benchmark scores were higher with the EAX850XTP than the AX850XTP, but (cue sarcastically dramatic music in a minor key) you won't be able to tell the difference when you're immersed in any of the games we tested.

The hiccup that tripped up the Extreme AX800 XT/2DT in Far Cry was back to pester the EAX850XTP. Our scores in 3DMark05 and Half-Life 2 took top honors among all the cards in our roundup, and our other results were also pretty impressive. Until we can get our grubby little hands on an R520 card or some CrossFire hardware, we're perfectly content with either version of the X850 XT PE. Trust us; they're as tasty as a steak sandwich.

The Bus Rolls On

Granted, there were a few exceptions, but our tests showed that while PCI-E might theoretically be a superior graphics bus, even some of the most demanding games won't eat up the available bandwidth AGP 8X has to offer. Don't let the neighborhood kids taunt you with AGP insults, because it's still a pretty capable architecture.

That said, AGP's days are numbered. While it hasn't happened yet, eventually software will saturate the AGP bus, so it makes sense that manufacturers are looking toward the future when they produce motherboards and graphics cards with PCI-E technology. Both NVIDIA's and ATI's multirendering require PCI-E graphics cards, so it's only a matter of time before trading in your AGP card becomes a fact of life. **CPU**

by Vince Cogley

SLI Showdown

A Gaggle Of Graphics Cards & A Mountain Of Mobos Compared

Quickly going from buzzword to breakthrough, NVIDIA's SLI (Scalable Link Interface) gives antsy power users the ability to rapidly and significantly boost their graphics power. Thanks to PCI Express technology, SLI lets you yoke two compatible graphics cards together to experience a performance upgrade that would make the Doublemint Twins blush.

Although the right SLI equipment will inspire both the adulation and envy of your LAN party peers, until a few months ago, such hardware was about as scarce as leftovers at a Struthers family reunion. Although you could cobble together an SLI system as a 2004 Christmas present, your choices of acceptable graphics cards and motherboards was considerably more limited than the options available today. And in the very near future, you won't be limited to using NVIDIA for your multirendering fix; ATI is set to drop its own benchmark-devouring technology on the world, too.

But with the glut of SLI products on the market these days, does any particular manufacturer excel at harnessing SLI? As a case study, we rounded up a pack of SLI motherboards and graphics cards from some of the leading manufacturers and threw our favorite bag of benchmarks into the mix to determine if there was a significantly superior combination.

How We Tested

We were constantly doing the Motherboard & Graphics Card Shuffle, but we stayed consistent with a number of components. When we tested our Socket 939 motherboards, we coziered up to AMD's Athlon 64 FX-55 and 1GB OCZ PC4400 RAM. We used a 3.73GHz Intel Pentium 4 Extreme Edition with 1GB Crucial Ballistix PC2-4300 RAM to test our two SLI-capable Socket 775 motherboards. We

used Window XP Professional SP2, Antec's TruePower 2.0 550W PSU, and Maxtor's 7,200RPM, 160GB DiamondMax Plus 9 SATA150 hard drive with both systems. To keep our video drivers consistent, we used the ForceWare 71.89 driver (released April 14, 2005), which was the most current driver at the time of this writing.

Our suite of benchmarks included Futuremark's 3DMark05 Build 1.2.0 and the following games: Unreal Tournament 2004, Far Cry, Doom 3, and Half-Life 2. We ran 3DMark05 at its default settings. In our game tests, we used 1,600 x 1,200 resolution, 4X antialiasing, and 8X anisotropic filtering. After running each graphics card/motherboard combination through our gauntlet at default core and memory clock frequencies (425MHz and 1.10GHz, respectively), we used Coolbits to squeeze extra power out of these already grievously powerful graphics cards.

AMD Mobos

AMD's CPUs may have had to wait longer than Intel's for the PCI-E graphics bus, but thanks to NVIDIA, they had first crack at SLI. As a result, we could be a little pickier selecting AMD-based motherboards.

MSI K8N Neo4/SLI

MSI NX6800Ultra-T2D256E. We started our SLI soiree with an MSI double dip. At default settings the MSI tandem performed quite well, turning in a good 3DMark05 score (9505) and taking home the top UT2004 score (107.7fps). Although the NX6800Ultra-T2D256E trailed both of the other graphics cards in Doom 3, Far Cry, and Half-Life 2, the deficit was too small to slight MSI's card in any way.

We nudged our core and memory clock frequencies up to 434MHz and 1.11GHz, respectively—slightly lower than the AOpen 6800Ultra-DVD256 and dead

even with Gigabyte's GV-NX68U256D-B. Our benchmark results also seemed to reflect this. With our 3DMark05 score actually dropping by 81 points and game frame rates increasing by only fractions, the NX6800Ultra-T2D256E started a trend that was fairly consistent. Without any aftermarket cooling, we had difficulties pushing any of our trio of graphics cards far beyond their default settings.

Gigabyte GV-NX68U256D-B. To say Gigabyte's graphics card was the worst 3DMark05 performer of the bunch when saddled to the K8N Neo4/SLI is a little like saying the second place horse in a photo finish was blown away. The GV-NX68U256D-B edged AOpen's offering in Far Cry and Half-Life 2 and wasn't far behind in Doom 3 or UT2004. It posted consistently great scores in all of our tests, hitting above 70fps in Far Cry, Doom 3, and Half-Life 2 and topping the century mark in UT2004.

We were able to overclock the GV-NX68U256-B to the same clock speeds as the MSI card and saw piecemeal improvements in all of our tests. Like the NX6800Ultra-T2D256E, overclocking hurt its 3DMark05 score, although its retreat wasn't as great.

AOpen 6800Ultra-DVD256. If we had our druthers, we'd take AOpen's card. It was probably the best overall card with the MSI board, but it was a close race. At stock settings, the 6800Ultra-DVD256 was the best card in 3DMark05 and Doom 3 but nipped at the heels of its counterparts, placing second in every other game test.

The 6800Ultra-DVD256's real advantage lies in its overclockability. Remember, the difference is mole hills rather than mountains, but AOpen's card showed the best improvement in 3DMark05 with a 213-point improvement. We overclocked the core and memory clock frequencies to 436MHz and 1.18GHz, respectively.

Gigabyte GA-K8N Ultra-SLI

MSI NX6800Ultra-T2D256E. Once again, MSI's graphics card produced solid results, but Gigabyte's AMD SLI mobo was slightly off the pace MSI's mobo set. The NX6800Ultra-T2D256E's 3D-Mark05 score was 47 points lower when

we paired it with the Gigabyte GA-K8N Ultra-SLI. In fact, this trend continued in every other game benchmark. In UT2004 the MSI NX6800Ultra-T2D256E “plodded” along about 5fps slower on the GA-K8N Ultra-SLI.

This graphics card/motherboard combination was far more amicable after an overclock. Not only did we overclock the NX6800Ultra-T2D256E to new heights (443MHz core clock speed and 1.13GHz memory clock speed), but it shot past its previous best 3DMark05 score with a 9602.

Gigabyte GV-NX68U256D-B. Just as our MSI twosome proved to be a formidable force, the double Gigabyte graphics card/motherboard tandem was quite effective, especially at default speeds. It edged the NX6800Ultra-T2D256E for the best stock 3DMark05 score and also had the best Doom 3 and Far Cry scores.

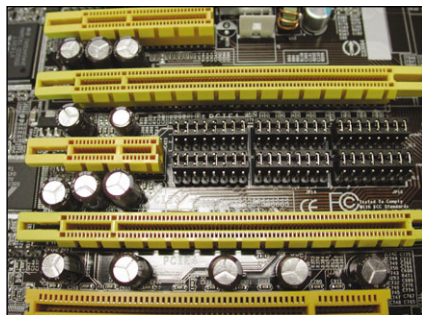
Oddly enough, the GV-NX68U256D-B didn’t respond well to overclocking. It went from first to worst in 3DMark05 and actually retreated in Doom 3, dropping from 71.1fps to 70.3fps. Without any third-party cooling products, our advice is to stick with stock settings.

AOpen 6800Ultra-DVD256. The 6800Ultra-DVD256 might have been our choice with the K8N Neo4/SLI, but the choice wasn’t as clear cut when we plopped AOpen’s 6800 Ultra cards in their respective PCI-E x16 slots and unleashed them on our block of benchmarks. Despite having the lowest stock 3DMark05 score, it tied the GV-NX68U256D-B in Doom 3 and yielded results that were on par with MSI’s and Gigabyte’s graphics cards in the other game tests.

We overclocked the 6800Ultra-DVD256 to 435MHz/1.12GHz, which was consistent with our overclocking efforts on the other SLI motherboards we tested. It did shoot past the GV-NX68U256D-B in 3DMark05 with a 9555 score, nearly 150 points better than its stock score.

DFI LAN Party nF4 SLI-DR

MSI NX6800Ultra-T2D256E. DFI’s LAN Party nF4 SLI-DR didn’t waste any time taking our graphics cards to new heights. It’s possible that the onboard



Although most of our mobos used a thin selector card to designate a single card or SLI configuration, DFI’s LAN Party nF4 SLI-DR uses a series of jumpers.

5V/12V Molex power connector (absent on the K8N Neo4/SLI and GA-K8N Ultra-SLI but included on the ASUS A8N SLI Deluxe) gave the motherboard and graphics cards extra gas for better scores; either way, the NX6800Ultra-T2D256E flirted with a five-figure 3DMark05 score, scoring 9996.

Although the LAN Party nF4 SLI-DR made our trio of graphics cards look great at default clock frequency settings, it proved no better at overclocking than the other Socket 939 mobos. We would, however, match the NX6800Ultra-T2D256E with the LAN Party nF4 SLI-DR for overclocking because it was the only graphics card that didn’t respond to overclocking with a net loss in 3DMark05 scores. But...

Gigabyte GV-NX68U256D-B. ...there’s something undeniably sexy about pulling down 10,000 3DMarks without any tinkering, and the GV-NX68U256D-B did just that (and we concede we’re doing a significant amount of hairsplitting over stock 3DMark05 scores). Although Gigabyte’s graphics card beat MSI’s card at stock settings in every game test but Half-Life 2, the difference was less than a frame per second in every test.

Overclocking the GV-NX68U256D-B produced such negligible gains that we’d prefer to keep the card at its stock settings. Improvements in our game test results were virtually nonexistent, and our 3DMark05 score actually dropped a few ticks.

AOpen 6800Ultra-DVD256. As we expected, the 6800Ultra-DVD256 also enjoyed its stay at the LAN Party nF4 SLI-DR Hotel, posting a robust score of

9970 in 3DMark05. AOpen’s card legged out victories in Doom 3 and Far Cry and did very well in Half-Life 2 and UT2004. Like MSI’s and Gigabyte’s card, an AOpen/DFI match is a great choice.

The 6800Ultra-DVD256 also maintained the trend the other two cards laid out when we overclocked it. We boosted the core clock speed and memory speed to 435MHz and 1.11GHz, respectively, but the card spat back scores that lead us to believe it was happier without any tinkering. Our 3DMark05, Far Cry, and Half-Life 2 scores all tumbled, and the improvements in Doom 3 and UT2004 were predictably miniscule.

ASUS A8N SLI Deluxe

MSI NX6800Ultra-T2D256E. The LAN Party nF4 SLI-DR is our AMD Alpha male, but ASUS’s A8N SLI Deluxe was an impressive second banana. Again, the NX6800Ultra-T2D256E came close to breaking the 10,000 point barrier in 3DMark05. It trailed DFI’s motherboard slightly in Half-Life 2 and UT2004, but the two were neck-and-neck in Far Cry.

Like the DFI motherboard, the NX6800Ultra-T2D256E was the only overclocked graphics card to show across-the-board improvement in every test we threw at it. It was quantitatively the best card we tested with the A8N SLI Deluxe.

Gigabyte GV-NX68U256D-B. Gigabyte’s champion wasn’t quite the graphics gladiator as was DFI’s motherboard, but we’d still happily take it into battle with us. At default speeds it posted the best Doom 3 and Half-Life 2 scores of the trio, with 75.1fps and 78.5fps, respectively. A slightly lower 3DMark05 score kept the GV-NX68U256-B from being undisputed best card for the A8N SLI Deluxe at stock speeds.

The GV-NX68256-B showed marginal improvement when we overclocked it. Our 3DMark05 score improved by 69 points, but while every game test also showed improvement, no game score increased by more than a frame per second.

AOpen 6800Ultra-DVD256. If you think AOpen doesn’t belong among the ranks of MSI and Gigabyte, think again. Not only did the 6800Ultra-DVD claim

the best stock 3DMark05 score on the A8N SLI Deluxe, it also snared first place in Far Cry and UT2004—not too shabby.

After we overclocked AOpen's graphics card's core and memory clock frequencies to 429MHz and 1.11GHz, it retreated slightly in some tests. The 6800Ultra-DVD256 actually gave back seven 3DMarks and was a hair slower in Doom 3. In truth, although our other game tests were higher after we overclocked the 6800Ultra-DVD256, our results could have easily flip-flopped.

Intel Mobos

If you wanted a cutting-edge chipset for your Intel processor, there was a pretty good chance you turned to Intel. But for dual-graphics awesomeness, NVIDIA also produced its nForce4 SLI chipset for Intel processors.

MSI P4N Diamond

MSI NX6800Ultra-T2D256E. MSI's Socket 775 motherboard really showed us

the difference a CPU makes. As far as gaming is concerned, AMD's Athlon 64 FX-55 (and let's not forget this isn't even the fastest FX processor on the shelves these days) is good for roughly 1500 extra 3DMarks. On the other hand, switching processors made relatively little difference in our game scores. In fact the P4N Diamond and NX6800Ultra-T2D256E teamed up to give us the best stock UT2004 score.

Because a couple of other overclocking attempts resulted in lower scores, we weren't surprised to see the NX6800Ultra-T2D256E produce lower results in a few tests. Half-Life 2's drop to 68fps was stunning, but we considered this a hiccup because 3DMark05 was the only test the overclocked NX6800Ultra-T2D256E stumbled on. It notched the highest UT2004 score again.

Gigabyte GV-NX68U256D-B. The GV-NX68U256D-B wasn't the best performer in any stock tests with the P4N Diamond, but it was still comparable

with its peers. Its Doom 3 score (75.3fps) was among the best of any graphics card/motherboard combos, and its other scores were equally solid.

We overclocked Gigabyte's graphics card to a 430MHz core clock and 1.11GHz memory clock speed, but like the NX6800Ultra-T2D256E, its 3DMark05 score experienced a 100+-point drop. We were a little more successful in the game tests; our 78.88fps Far Cry score was among the crème de la crème.

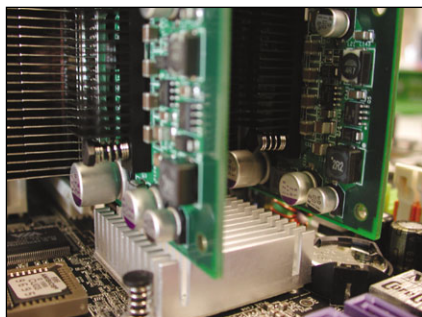
AOpen 6800Ultra-DVD256. Once again, AOpen's offering proved its worth, turning in top scores in 3DMark05 (8383), Far Cry (78.05fps), and Half-Life 2 (78.37fps). When it wasn't beating its compatriots outright, it was putting up numbers that didn't lag far behind. It was competitive in Doom 3 and only lagged behind the NX6800Ultra-T2D256 by 0.5fps in UT2004.

The 6800Ultra-DVD256 turned in the best stock 3DMark05 score between our two Intel-based SLI boards, and it did the same when we overclocked it (8484). In fact, it was the only graphics card of the three to show net gains in every test when we overclocked it on the P4N Diamond.

Double Your Graphics, Double Your Fun

We've seen technologies that were more a product of slick marketing than solid engineering, but SLI is far from a parlor trick. Take a look at the cold, hard numbers below, and you'll agree you're getting a pretty decent return on a (rather hefty) investment. ▲

	Core Overclocked	Memory Overclocked	3DMark05	Doom 3	Far Cry	Half-Life 2	Unreal Tournament 2004
MSI K8N Neo4/SLI							
MSI NX6800Ultra-T2D256E	434MHz	1.11GHz	9505	71.6fps	76.08fps	77.15fps	107.7fps
Gigabyte GV-NX68U256D-B	434MHz	1.11GHz	9485	72.4fps	77.38fps	77.66fps	107.4fps
AOpen 6800Ultra-DVD256	436MHz	1.18GHz	9510	72.5fps	77.02fps	77.53fps	107.6fps
Gigabyte GA-K8N Ultra-SLI							
MSI NX6800Ultra-T2D256E	439MHz	1.12GHz	9458	71.1fps	73.01fps	73.4fps	102fps
Gigabyte GV-NX68U256D-B	434MHz	1.11GHz	9469	71.4fps	73.12fps	73.03fps	101.2fps
AOpen 6800Ultra-DVD256	435MHz	1.12GHz	9409	71.4fps	73.03fps	72.18fps	101.4fps
DFI LAN Party nF4 SLI-DR							
MSI NX6800Ultra-T2D256E	436MHz	1.11GHz	9996	74.7fps	78.63fps	82.24fps	112.1fps
Gigabyte GV-NX68U256D-B	429MHz	1.11GHz	10000	75.6fps	78.72fps	82.14fps	112.6fps
AOpen 6800Ultra-DVD256	435MHz	1.11GHz	9970	75.9fps	78.8fps	82.05fps	112.5fps
ASUS A8N SLI Deluxe							
MSI NX6800Ultra-T2D256E	434MHz	1.11GHz	9909	74.9fps	77.47fps	78.44fps	106fps
Gigabyte GV-NX68U256D-B	428MHz	1.10GHz	9850	75.1fps	77.29fps	78.5fps	106.1fps
AOpen 6800Ultra-DVD256	429MHz	1.11GHz	9931	74.8fps	77.48fps	78.33fps	106.1fps
MSI P4N Diamond							
MSI NX6800Ultra-T2D256E	439MHz	1.12GHz	8224	75.7fps	73.6fps	76.85fps	114.8fps
Gigabyte GV-NX68U256D-B	430MHz	1.11GHz	8336	75.3fps	76.87fps	76.45fps	114.3fps
AOpen 6800Ultra-DVD256	428MHz	1.10GHz	8383	75.01fps	78.05fps	78.37fps	114.3fps
ASUS P5ND2-SLI Deluxe							
MSI NX6800Ultra-T2D256E	441MHz	1.13GHz	8342	73.4fps	74.9fps	74.7fps	103.9fps
Gigabyte GV-NX68U256D-B	429MHz	1.11GHz	8343	73.7fps	74.29fps	73.72fps	103.5fps
AOpen 6800Ultra-DVD256	434MHz	1.11GHz	8367	71.7fps	75.09fps	74.12fps	103.9fps



There's nothing like using a passive heatsink on the nForce4 SLI chipset to give the inside of your case that warm, toasty feeling.

ASUS P5ND2-SLI Deluxe

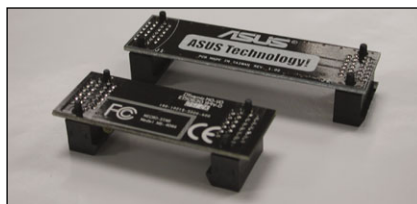
MSI NX6800Ultra-T2D256E. The NX6800Ultra-T2D256E kicked off our final motherboard, another ASUS offering, with results that were similar to what we experienced with the P4N Diamond. A one-point deficit separated MSI's graphics card from the GV-NX68U256D-B in 3DMark05, but the NX6800Ultra-T2D256E scored victories in both the Half-Life 2 and UT2004 timedemos.

Although the NX6800Ultra-T2D256E picked up almost 100 points in 3DMark-05 when we overclocked it (441MHz/

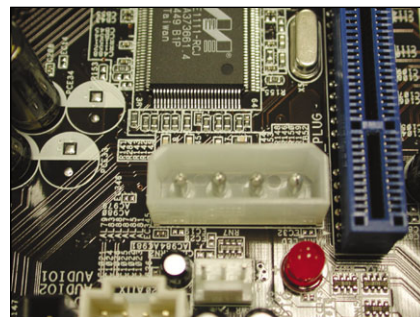
1.13GHz), it was a few frames per second off the pace it set at stock settings in Doom 3 and Half-Life 2.

Gigabyte GV-NX68U256D-B. Again, Gigabyte's GV-NX68U256D-B found itself as a bridesmaid and rarely a bride in our stock tests. It posted the best Doom 3 score (73.7fps) but found itself on the outside looking in on every other test. Once again, we should stress that this difference was almost always less than a frame per second in every game test.

The GV-NX68U256D-B was the weakest overclocker on the P5ND2-SLI Deluxe (429MHz/1.1GHz), but it was the only graphics card to show more than 1fps improvement in every game test. Its 75.69fps in Far Cry was the best of the trio.



ASUS's SLI connector was slightly longer than other motherboards, giving a little space (read: airflow) between our monstrous 6800 Ultra cards.



A couple of motherboards have onboard Molex connectors to provide extra stability for SLI setups.

AOpen 6800Ultra-DVD256. AOpen's graphics card didn't disappoint us in its final hurrah, serving the NX6800Ultra-T2D256E and GV-NX68U256D-B a heaping plate of defeat in 3DMark05 and Half-Life 2. It also tied the MSI card in UT2004. Overall, the 6800Ultra-DVD256 made a strong case as the best stock card.

We didn't see quite as much dominance when we overclocked the 6800Ultra-DVD256. It dropped to second in 3DMark05, Far Cry, and UT2004, but it showed nice gains in Doom 3 (3.5fps improvement) and Half-Life 2 (1.17fps).

High On SLI

After the dust settled, we took away a few important insights from our SLI battle royale. For graphics cards a clear winner really didn't emerge among the three cards we tested. In general, we thought the AOpen 6800Ultra-DVD256 had a slight edge in our stock tests, and the MSI NX6800Ultra-T2D256E gave us the best results of any overclocked card.

Our mobos told a different story. The Athlon 64 FX-55 was clearly the superior gaming CPU. To further narrow the field, DFI's and ASUS's Socket 939 motherboards were a cut above MSI's and Gigabyte's. The LAN Party nF4 SLI-DR may have a slight advantage over the A8N SLI Deluxe, but you probably won't notice a difference.

Until ATI's Crossfire bears tangible fruit, dual graphics is a one-sided contest. But if you believe the hype from ATI, we'll have a real graphics shootout on our hands once Crossfire mobos hit the market. **CPU**

by Vince Cogley

3DMark05 Overclocked	Doom 3 Overclocked	Far Cry Overclocked	Half-Life 2 Overclocked	Unreal Tournament 2004 Overclocked
9424	72.7fps	77.56fps	78.39fps	108.7fps
9429	72.6fps	77.25fps	78.39fps	108.5fps
9723	74.7fps	78.15fps	79.17fps	110.5fps
9602	72.7fps	73.97fps	74.14fps	103.7fps
9516	70.3fps	73.47fps	73.85fps	102.6fps
9555	72.4fps	73.3fps	74.05fps	102.6fps
10116	76.9fps	79.88fps	83.17fps	113.5fps
9944	77fps	78.84fps	83.99fps	112.7fps
9898	77.1fps	72.15fps	78.43fps	113.7fps
10033	76.5fps	78.99fps	79.22fps	107.3fps
9919	75.4fps	78.54fps	78.72fps	106.8fps
9924	73.4fps	77.74fps	78.4fps	106.2fps
8119	76.5fps	74.65fps	68fps	117.2fps
8175	75.9fps	78.88fps	78.13fps	115.9fps
8484	75.8fps	78.73fps	78.71fps	114.9fps
8435	72.9fps	75.32fps	73.8fps	106.2fps
8408	75fps	75.69fps	74.9fps	104.7fps
8411	75.2fps	75.31fps	75.28fps	104.7fps

Multiple Personalities

There's More To A CPU Than Clock Speed

Every day, dozens of press releases flood our inboxes, fax machines, and occasionally, our mailroom, spewing more hype than ads for a summer blockbuster movie. Outrageous claims are par for the course on the retail side of the computer industry, but most new PC enthusiasts don't even have enough computer knowledge for the really crazy claims to confuse them.

That's not to say that computer newbies don't get suckered: they do. But most of these casual users (and the occasional expert) succumb instead to a different type of hype: the inaccurate measurement. PR representatives and sales people pound component specifications into customers' heads constantly, and it only makes (business) sense that they would use specs that sound a little better than they really are to inexperienced buyers. As a result, customers often think they're buying a better device than they're getting or they focus on a particular specification (ignoring other important specs). Some cases are more deceptive than others.

The Art Of The 'Gotcha' Measurement

Take hard drive capacities as an example of a confusing but widely accepted labeling practice. Manufacturers slap some hefty capacities onto their hard drives. Many users take a look at the drive's capacity and assume that the number indicates the amount of data the drive can actually hold. An 80GB hard drive holds 80GB of data, right? Not really, it turns out. Manufacturers measure storage space in binary format (powers of two) instead of decimal format (powers of 10).

The manufacturers express the measurements on the packaging in decimal format, which just happens to be the larger number. And, of course, the operating

system eats some hard drive space, as well. An ad that claims a computer has an 80GB hard drive isn't suggesting that you can load 80GB of data onto it; you'll find that the OS sits on some of the space and that the hard drive is actually a few GB smaller than 80GB to begin with. Most consumers don't know about the binary-decimal difference, so they're duped: They think they're looking at the important number when they're not.

The processor labeling war is only a little different. Most consumers base their purchases on clock speed (2.8GHz, for example). Unlike hard drive storage, the processor clock speed doesn't have two measurement types—a 2.8GHz processor really runs at 2.8GHz. The problem is that consumers think that the clock speed is the definitive measurement of a CPU's performance and that faster must mean better.

If clock speed really was the only factor that affected a processor's performance, CPU manufacturers wouldn't offer different processor families for different types of computers, and you could spot the best processor for any task instantly based on its speed. But the truth is that a processor's architecture has a huge impact on its performance. A 2GHz AMD Duron processor, for example, has a weaker architecture that makes it no match for an AMD Athlon XP that runs at 2GHz. Instruction sets, process types, busses, and caches all play a role in a processor's performance.

AMD vs. Intel

Intel kicked off the naming battle by including the clock speed in its processor names. Sales people were quick to point out to customers that a computer boasting a faster processor clock speed also carried a larger price tag. A bigger price tag and a

faster clock speed: It just had to be better. And in the early years of the Intel Pentium 4, faster clock speeds did generally indicate better performing processors. The real consumer disconnect at that point was between the Intel and AMD clock speeds. AMD Athlon XPs, which used a different architecture to process information, didn't need such high clock speeds to perform well. Reviewers proved this time and again by matching up Intel and AMD processors and using benchmarks (which are objective, if not completely faultless, methods of measuring component or whole system performance). But AMD processors consistently had lower clock speeds than comparable Intel procs.

AMD couldn't sell processors by including clock speeds in the CPU names: The average consumer would take one look at a 2.8GHz Intel P4 and a 2.083GHz AMD Athlon XP and then choose the P4. To that end, AMD chose a naming scheme that let it mask the CPU clock speed and equate the processor with its approximate Intel counterpart. For example, AMD's Athlon XP 2800+ (which has a 2.083GHz clock speed) graced home computers and retail shelves around the same time the 2.8GHz Intel P4 took the spotlight. Of course, these naming schemes didn't lead to exact performance matches, but they let consumers compare processors without knowing the details of processor clock speeds for both companies.

As features other than clock speed began playing an increasingly important role in Intel processor performance and faster clock speeds became harder to obtain, the chipmaker introduced a new naming scheme. In 2004, Intel dropped clock speeds from its CPU names and introduced numbered models, including 3xx for Intel Celeron Ds, 7xx for Pentium Ms, and 8xx for both Pentium (not Pentium 4) Extreme Editions and Pentium Ds.

AMD stopped developing new Athlon XPs around the same time and introduced the Athlon 64, a 64-bit processor that is faster than 32-bit counterparts and is compatible with both 64-bit and 32-bit operating systems. AMD stuck with its previous XXXX+ naming scheme for standard Athlon 64 processors, but switched to the

The True Test Of CPU Performance

Clock speed contributes to a processor's performance, but users who assume it's the only factor are likely to ignore other important features, such as FSB and L2 caches. We compared several 2.2GHz models at default clock speeds, but we don't call this issue PC Modder for nothin'; we also overlocked each processor to see how it handled the pressure. ▲

CPU	AMD Athlon XP 3200+	AMD Athlon MP 2800+	AMD Opteron 148	AMD Athlon 64 3700+	AMD Athlon 64 FX-51	Intel Pentium 4 3.2	Intel Pentium 4 3.2E	Intel Pentium 4 3.2 Extreme Edition
Core	Barton	Barton	ClawHammer	San Diego	ClawHammer	Northwood	Prescott	Galatin
Socket	A	A	940	939	940	478	478	478
Default FSB	400MHz	266MHz	800MHz*	800MHz*	800MHz*	800MHz	800MHz	800MHz
L2 Cache	512KB	512KB	1MB	1MB	1MB	512KB	1MB	1MB
Price**	\$132	\$199	\$270	\$260	\$550	\$222.99	\$203	\$776.25
Motherboard	SOYO SY-SYKT880 Dragon2 v.2.0	SOYO SY-SYKT880 Dragon2 v.2.0	Tyan Tiger K8W	ASUS A8V Deluxe	Tyan Tiger K8W	ASUS P4C800-e Deluxe	ASUS P4C800-e Deluxe	ASUS P4C800-e Deluxe
Chipset	VIA KT880	VIA KT880	VIA K8T800	VIA K8T800	AMD-8111	Intel 875P	Intel 875P	Intel 875P
Default Clock	2.2GHz	2.13GHz	2.2GHz	2.2GHz	2.2GHz	3.2GHz	3.2GHz	3.2GHz
Overclocked To	2.35GHz	2.27GHz	N/A	2.4GHz	N/A	3.55GHz	3.6GHz	3.49GHz
3DMark05	1017 (834)	1011 (971)	1035	1030 (947)	1038	1035 (1037)	1037 (1040)	1002 (1034)
PCMark04	3775 (3980)	3432 (3615)	4477	4328 (4810)	4464	4848 (5097)	3925 (4264)	4699 (4744)
CPU	3712 (3937)	3424 (3643)	4127	4201 (4550)	4154	4654 (4624)	3584 (3704)	4164 (4315)
Memory	2592 (2767)	2035 (2084)	5377	5157 (5611)	5362	4512 (4419)	4607 (4139)	4916 (4684)
Graphics	3638 (3465)	3553 (3474)	4105	3436 (4365)	4108	4036 (3993)	4046 (3997)	4749 (4070)
HDD	4484 (4517)	4491 (4490)	4339	4476 (4512)	4318	4145 (4239)	4173 (4192)	4175 (4201)
Doom 3	42.4 (30.9)	No Scores	23.8	20.2 (20.2)	23.7	20.1 (20.1)	20.1 (20.1)	20.1 (20.1)

* Effective FSB. Actual FSB is integrated into chip

** Lowest price from www.pricegrabber.com as of 07/20/05

*** Lowest price from www.froogle.google.com as of 07/20/05

AMD Athlon XP 3200+	AMD Athlon MP 2800+	AMD Opteron 148	AMD Athlon 64 3700+	Athlon 64 FX-51	Intel Pentium 4 3.2	Intel Pentium 4 3.2E	Intel Pentium 4 3.2 Extreme Edition
Barton	Barton	ClawHammer	San Diego	ClawHammer	Northwood	Prescott	Galatin
A	A	940	939	940	478	478	478
400MHz	266MHz	800MHz*	800MHz*	800MHz*	800MHz	800MHz	800MHz
512KB	512KB	1MB	1MB	1MB	512KB	1MB	1MB
\$132	\$199	\$270	\$260	\$550	\$222.99	\$203	\$776.25
ASUS A7N8X-E Deluxe	ASUS A7N8X-E Deluxe	Gigabyte GA-K8NNXP-940	MSI K8n Neo2 Platinum	MSI Master2-FAR	ASUS P4P800-e Deluxe	ASUS P4P800-e Deluxe	ASUS P4P800-e Deluxe
NVIDIA nForce 2 Ultra	NVIDIA nForce 2 Ultra	nForce pro-150	nForce3 Ultra	nForce pro-150	Intel 865PE	Intel 865PE	Intel 865PE
2.2GHz	2.13GHz	2.2GHz	2.2GHz	2.2GHz	3.2GHz	3.2GHz	3.2GHz
2.46GHz	2.37GHz	2.25GHz	2.4GHz	2.32GHz	3.6GHz	3.62GHz	3.55GHz
1035 (1035)	1033 (1025)	431 (439)	439 (445)	1038 (1036)	1026 (1025)	1033 (1027)	973 (1027)
3801 (4200)	3526 (3915)	4027 (4154)	3776 (4080)	4390 (4710)	4684 (5078)	4899 (5359)	5076 (5300)
3691 (4105)	3466 (3896)	4092 (4219)	4115 (4425)	4146 (4340)	4735 (5248)	4903 (5522)	4778 (5362)
2697 (2990)	2155 (2402)	3712 (3810)	2909 (3165)	3803 (3998)	4440 (4424)	4849 (4657)	4835 (4763)
3882 (3899)	3812 (3839)	3296 (3303)	3899 (2903)	3900 (3968)	3816 (3820)	3852 (3855)	4764 (3893)
4485 (4480)	4488 (4516)	4473 (4525)	4305 (4311)	4540 (4511)	4198 (4219)	4186 (4216)	4195 (4183)
20.2 (20.2)	20.1 (20.1)	38.2 (40.1)	14.7 (15.1)	71.6 (71.1)	20 (20.1)	20.4 (20.2)	20.1 (20.1)

* Effective FSB. Actual FSB is integrated into chip

** Lowest price from www.pricegrabber.com as of 07/20/05

*** Lowest price from www.froogle.google.com as of 07/20/05

Anatomy Of Speed

Comparable AMD and Intel processors have such different clock speeds because each has a different method for processing data. Thus, many online retailers list additional specs when promoting CPUs. We'll cover the basics on the two specs you're most likely to see while shopping for the brains of your next system.

Cache. Any online store that lists a processor's specs will almost certainly mention the cache sizes, as this built-in memory can give the CPU a serious performance boost. Thanks to the memory cache, the processor can store some often-used data close by so it doesn't need to retrieve said data from memory. Your motherboard memory may not seem far away to you, but when your system is crunching data in milliseconds, the trip to the cache is much shorter than the trip to the RAM. Most processors have two types of cache memory: L1 and L2. L1 is smaller than L2 and often splits into a general data area and a machine instruction area, so you may see retailers display the L1 cache as 64KB + 64KB. In these cases, you can add the two capacities to find the total L1 capacity. L2 cache is much larger, though still tiny compared to the gigabytes of memory that sit in your motherboard's memory slots. Expect to see L2 caches as big as 1MB to 2MB on

high-end processors. Some processors also sport an L3 cache.

Instruction sets. Early on in the processor game, manufacturers found that CPUs could increase performance when running certain applications if they had special instructions that let them process data more efficiently. As a result, today's processors carry a variety of instruction sets, each of which enhances performance when you run the appropriate type of application. Software publishers must build support into their applications to take advantage of instruction sets, but the good news is that you won't run into a situation in which you can't run a program because your processor lacks the appropriate instruction set—these are simply performance boosters. Common instruction sets include MMX (Multimedia Extension) and SSE (Streaming SIMD Extension), SSE2, and SSE3, which boost performance in CAD, video, and audio applications. Many processors also have 3DNow!, which boosts audio, video, and modem performance.

These specs, along with the clock speed, let you quickly size up CPUs, but don't overlook the processor's family name: Intel Celeron and AMD Duron processors are inexpensive CPUs that lack the power their Intel Pentium 4 and AMD Athlon XP/64 brethren provide. ▲

class designator "FX" when it released the enthusiast version of its 64-bit processor. AMD also chose two-digit model numbers. Thus, the FX processor series includes the Athlon 64 FX-51, FX-53, FX-55, and FX-57. According to AMD, it uses odd numbers to make the model name "stand out."

But the damage has already been done. The new names simply indicate new CPUs, so PC users who know as little about their computers as they know about their cars still look for clock speed when they buy systems. As long as retailers can sell computers by wowing customers with clock speeds, they'll rule many purchasing decisions.

That said, both chipmakers recently introduced a new feature that may steal some of the clock speed limelight: dual-core processors. Customers have learned

that more is often better in the computer world, so we may see customers buying processors based on how many cores they carry. When shopping, keep in mind that while dual-core CPUs handle multiple applications simultaneously, they haven't yet eclipsed single-core processors in terms of raw, single-application performance.

CPU Roundup

We compared a variety of 2.8GHz Intel processors and a few AMD CPUs in *PC Modder 2.0* (see "The Many Faces Of 2.8" on page 115 of that issue). This time, we're focusing on a lower clock speed and turning our attention to the AMD processors. AMD's newest processor types start at clock speeds higher than 2.2GHz, but we found a slew of 2.2GHz CPUs that still

sell at online and offline computer retailers. We also tossed in a few Intel CPUs, but we chose the 3.2GHz P4s, which we hoped would best match the AMD procs. We tested each processor on two motherboards, each of which sported a different chipset, which let us get a feel for whether one chipset or the other worked particularly well with that processor.

We recorded each processor's benchmark scores at stock settings and added a little flavor to the roundup by overclocking the CPUs. Because we used some boards more than once, we didn't mess with the CPU voltage, a setting that can sometimes fry a motherboard. Instead, we focused on raising the clock speed to the system's highest stable setting. Although a processor's clock speed isn't the only performance factor, it's the easiest feature to manipulate when you're trying to squeeze every last drop of power from your CPU.

What We Tested

As with any roundup, we tried to stock our test systems with identical components so we could focus on the performance of the roundup devices. We almost always run into emerging technologies that force us to shake up the test system spec lists a little, but we didn't run into much trouble this time around. Although PCI-E is quickly eclipsing AGP as the video bus of choice, we stuck to AGP so we could accommodate all of the processors we came across.

Our test systems each included a 400W CoolMax CX-400B power supply, a 128MB Gainward FX PowerPack! NVIDIA GeForce FX 5900 XT graphics card, a 1GB kit of OCZ PC4400 OCZ5501024ELDCGLE-K memory (two 512MB DIMMs), and an 80GB Maxtor Diamondback 6Y080M0 hard drive. Identical optical drives are scarce at *CPU* headquarters when the *PC Modder* issue rolls around, but we stuck to CD-ROMs for consistency's sake. Each PC also sported a Sony MPF920 floppy drive. We hate to rely on floppy drives in the age of DVDs and flash drives, but AMD-based systems that have SATA hard drives require drivers during Windows installation, so we scrounged up a few floppies and loaded the drivers via the archaic drives.

Our CPU lineup stretches across several AMD processor families. The Athlon MP 2800+ is the only CPU here that can't claim a full 2.2GHz clock speed: We let it sneak in at 2.13GHz. It's a Socket A processor, so we paired it and the Athlon XP 3200+ with the ASUS A7N8X-E Deluxe and SOYO SY-K7V880. We also grabbed an Opteron 148 and the 940-pin version of the Athlon 64 FX-51 (new FX CPUs have 939 pins). We plugged these CPUs into two of the first non-server mobos to support the 940-pin processors: the ASUS SK8N and SK8V. As fate would have it, both boards tossed in the towel early. Each board was in a different test system, so we don't suspect a malicious PSU or other component. Instead, we're pretty sure that we mortally wounded these boards during a previous overclocking session in which we pushed the voltage through the roof. (Whoops).

We replaced the SK8N, which has the NVIDIA nForce3 chipset, with the Gigabyte GA-K8NNXP-940, which also has the nForce3. Oddly enough, the FX-51 refused to work with this board (although we've paired the two successfully in the past), so we matched the Gigabyte board to the Opteron 148 and the MSI K8T Master2-FAR to the FX-51. We had a tougher time finding a board to replace the SK8V and its VIA K8T800 chipset, so we branched into the server world and rustled up a Tyan Tiger K8W dual-socket board that sports AMD's 8111 and 8151 chips.

The Athlon 64 Mobile 3400+ sports 754 pins, so we chose the ASUS K8V SE Deluxe and K8N motherboards. We stuck with ASUS again when we picked out the Athlon 64 3700+'s VIA-based mobo (ASUS A8V Deluxe), but we broke the trend when we settled on the MSI K8N Neo2 Platinum, which represented NVIDIA's nForce3 Ultra.

After tossing a few ideas around, we picked the 3.2GHz Intel P4's standard, Prescott, and Extreme Edition versions. We also dug up two motherboards that supported all three processors and had AGP slots: the ASUS P4C800-e Deluxe (Intel 875P) and the ASUS P4P800-e Deluxe (Intel 865PE).

How We Tested

Once we rounded up our components, we rolled out the benchmarks. Our 3D lineup includes Futuremark's 3DMark05 and one of today's most popular and physically demanding games, Doom 3. 3DMark05, which runs a series of custom 3D demos, lets us compare PC configurations based on an easy to understand score: higher is better. Doom 3, on the other hand, is a true game. We used Doom 3's built-in demo to determine the frame rate.

Although many users are either casual or hardcore gamers, most also use their computers to run other applications, including business and entertainment programs. To that end, we also run Futuremark's PCMark04, which simulates standard office tasks. Unlike 3DMark05, which bases much of its score on the video card's performance, PCMark04 tests (and provides separate scores for) the CPU, graphics card, hard drive, and memory. The benchmark also provides an easy-reference overall score.

Benchmarks tax the PC's CPU and other resources heavily, so they make great stress tests. When you overclock a PC, you'll find that it can probably load Windows at high settings, but then crash during 3DMark05. We overclocked our test systems to the fastest speeds at which they could complete all of our benchmarks. This method isn't foolproof, but it adequately tests system stability.

When The Dust Settles

Even though we ran two identical test systems, we spent weeks testing our pile of processors and motherboards. Our intrepid techs, John Zhang and Justin Harsh, battled the unruly systems day and night to get the benchmark scores before we went to press. The chart confirms what we already knew: that the clock speed alone does not make a processor. But the chart also offers a look at each processor's strengths and weaknesses, as well as the all-important overclockability. Sure, you probably won't overclock an Athlon MP anytime soon, but if you ever do, you'll enter the ring informed.

Thanks to our lower-rung video card, all of the 3DMark05 scores were fairly low. But we weren't looking for high scores: we wanted to see how the CPUs affected the

numbers. All three Intel CPUs provided decent scores at default speeds, although we were surprised to see that the Extreme Edition didn't take top on honors, even among its own. It also didn't show exciting 3DMark05 score increases when we overclocked it, but it offered solid PCMark04 scores at both default and overclocked settings. The P4C800-e proved to be a better board for gamers who have an Extreme Edition, but the P4P800-e is the best board for office tasks. We found that this held true for the other Intel processors as well; the P4P800-e is really the better buy.

On the AMD side of things, the FX-51 took a huge lead at default settings, even when we plugged it into the Tiger, which better serves corporate settings. The Tiger produced low Doom 3 frame rates but it offered the same 1038 3DMark05 score as the MSI board and produced a slightly higher PCMark04 score at 4464. We'd still take the Master2-FAR over the Tiger, as the MSI board has frequency and voltage overclocking capabilities.

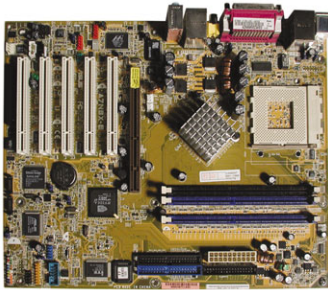
The Athlon XP 3200+ turned out to be a solid, well-rounded processor. Although its PCMark04 scores of 3775 (Dragon2) and 3801 (A7N8X-E) didn't come close to the FX-51's scores, the CPU provided solid scores (low 1000's) in 3DMark05. Not surprisingly, the FX-51 slammed the 3200+ in Doom 3: the 3200+ could top 42.2 fps on the Dragon2 (and it scored a miserable 20.2 at both stock and overclocked settings). That said, the A7N8X-E offered better overclocking (the 3200+ jumped to 2.46 and probably could reach much faster speeds) and a whopping 4200 in PCMark04 at overclocked settings.

The Price Of Performance

Not surprisingly, price turned out to be a fairly decent indicator of a processor's performance at stock settings. The Athlon FX-51, which is available for as little as \$550 to as much as \$825 online, produced smoking scores. That said, the best way to find a decent overclocker is to browse this article and others in the case studies section, which have tons of information on new CPUs' overclockability. **CPU**

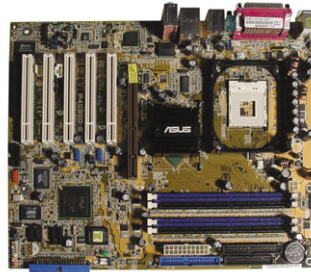
by Joshua Gulick

Motherboards We Used To Test



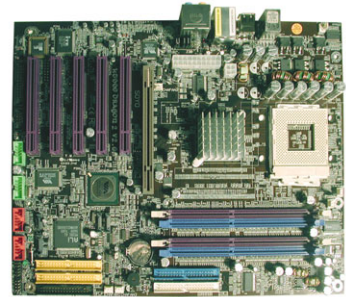
ASUS A7N8Xe Deluxe

Chips tested: AMD Athlon MP 2800+,
AMD Athlon XP 3200+



ASUS P4C800-e Deluxe

Chips tested: Intel Pentium 4 3.2, Intel Pentium
4 3.2E, Intel Pentium 4 3.2 Extreme Edition



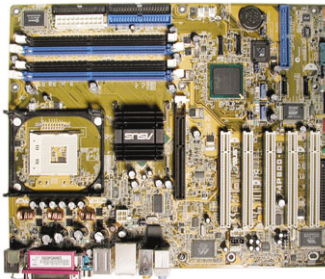
SOYO KT880 Dragon2. 2.0

Chips tested: AMD Athlon MP 2800+, AMD
Athlon XP 3200+



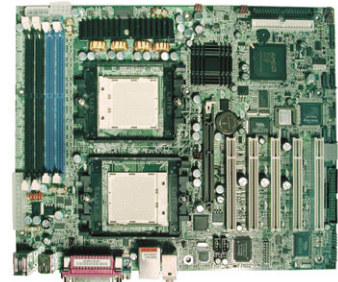
ASUS A8V Deluxe

Chip tested: AMD Athlon 64 3700+



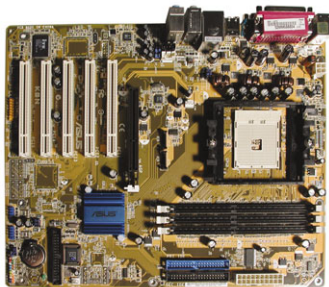
ASUS P4P800-e Deluxe

Chips tested: Intel Pentium 4 3.2, Intel Pentium
4 3.2E, Intel Pentium 4 3.2 Extreme Edition



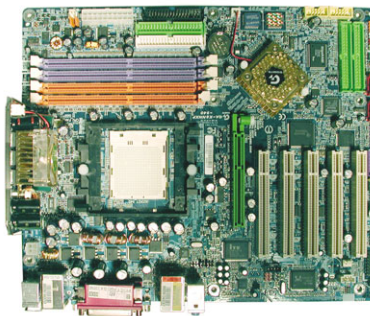
Tyan Tiger K8W

Chips tested: AMD Athlon 64 FX-51, AMD
Opteron 148



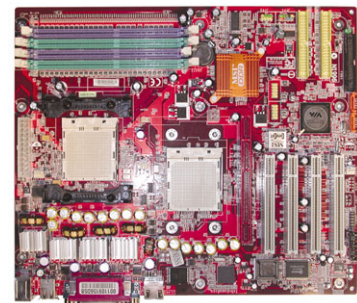
ASUS K8N

Chip tested: AMD Athlon 64 Mobile
3400+



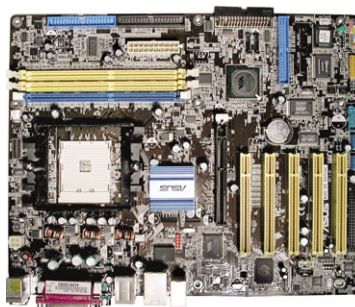
Gigabyte GA-K8NXP-940

Chip tested: AMD Opteron 148



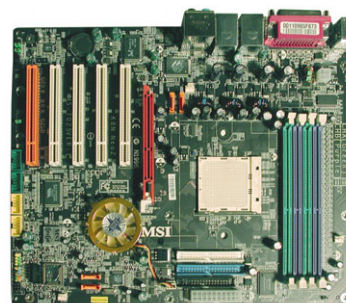
MSI K8T Master2-FAR

Chip tested: AMD Athlon 64 FX-51



ASUS K8V SE Deluxe

Chip tested: AMD Athlon 64 Mobile 3400+



MSI K8N Neo2 Platinum

Chip tested: AMD Athlon 64 3700+

DDR2 Drag Race

How Today's Fastest Memory Performs

DDR2 has not yet overtaken the popularity of DDR. However, with more Intel 925X, 925XE, and 955X and NVIDIA nForce4 SLI boards on the market, DDR2 is gradually gaining a foothold. We tested several current DDR2 modules, all with frequencies of at least 667MHz, to see how they perform.

How We Tested

We've noticed that some manufacturers use the labels of PC2-5300 and PC2-5400 interchangeably for either 667MHz or 675MHz memory. For our purposes, we grouped memory by its DDR2 classification to ensure comparisons based on the actual rated frequency. We compared memory from eight manufacturers: Corsair, Crucial, GeIL, Kingston, Mushkin, O CZ Technology, PQI, and Wintec.

Our test PC included an ASUS P5WD2 Premium mobo, an Intel 3.46GHz P4 EE CPU, an NVIDIA GeForce 6800 GT-based video card, an 80GB Maxtor 6Y080M0 7,200rpm SATA drive with 8MB cache, and WinXP Home. Both the motherboard and the CPU support a 1GHz FSB. A board with an 800MHz FSB would only support 533MHz memory unless we increased the DRAM:CPU ratio. Our fastest DDR2 had an 800MHz frequency, which would have required a 1:1 ratio with an 800MHz board. We knew we would have better results with our high-frequency memory if we used a 1GHz FSB board, such as the P5WD2 Premium.

We tested with 1GB dual-channel configs, with a 512MB stick in each of two dual-channel slots. Whenever possible, we ordered a dual-channel kit with matched modules. Otherwise, we bought two separately packaged modules and installed them in a dual-channel configuration.

We started by testing each pair of modules with SiSoftware Sandra 2005's Memory Bandwidth test. We ran the test multiple times, with each pair of memory modules running at one of several frequencies: 533MHz, 667MHz, 711MHz, 800MHz, and, if possible, 889MHz and 1GHz. The P5WD2's BIOS Setup Utility provided options for setting the memory frequency to run asynchronously with the CPU frequency. This let us operate a fairly stable system by adjusting the DRAM:CPU ratio to alter the frequency of only the memory and not of the proc. When we tested DDR2 six months ago, we could only select one of two DRAM:CPU ratios, 2:3 or 3:4. The 3:4 ratio was often unstable, so we had to increase the FSB and OC the CPU in order to reach DDR2 frequencies higher than 533MHz. This time, our mobo provided more control over operating frequencies. Some of our scores were lower because we did not overclock the CPU, but as a result, these scores are more indicative of memory performance.

After running Sandra 2005's Memory Bandwidth benchmark at as many of the preset frequencies as possible, we ran several other tests: FutureMark's 3DMark05's Game Tests, id Software's DOOM III timedemo (set at High quality and 800 x 600 resolution and run twice), and FutureMark's PCMark05's System Suite and Memory benchmarks.

DDR2-667 (PC2-5300 & PC2-5400)

Whereas we struggled to find DDR2-667 memory for our last issue of *PC Modder*, this time, we found several modules designed to run at 667MHz. CAS latencies for these modules varied somewhat, as we will discuss in more detail when we cover the specs and performance of each product.

Corsair ValueSelect PC2-5300 VS512MB667D2. The first memory we tested was from Corsair's ValueSelect line. Corsair's ValueSelect PC2-5300 has latency timings of 5-5-5-12. As a member of the ValueSelect line, it does not have a heatspreader. This memory was not one of our top performers, but it did perform well considering that it was the only memory we tested that did not have the benefit of a heatspreader. We could run this memory at its advertised timings at 533MHz, but in order to run all of our tests stable, we had to drop the timings just slightly to 5-5-5-15. To overclock the Corsair PC2-5300, we had to further drop the timings to 5-6-6-2.

When we ran Corsair's PC2-5300 at its intended 667MHz frequency, it achieved neither the highest nor lowest scores on any of our tests. The Sandra scores were a respectable 2843 Int ALU and 2861 Float FPU. In 3DMark05, the Corsair ValueSelect memory had a score of 4881, which was not much lower than the top competitors in this category. Doom 3 frame rates were on the high end of average, at 74.7fps for the first run and 106fps for the second run. Similarly, PCMark04 scores were respectable but not the highest of the DDR2-667 memory. We achieved a System Suite score of 5611 with the Corsair PC2-5300 installed and a Memory benchmark score of 5922.

When we set the DRAM:CPU ratio at 2:3 to run the Corsair PC2-5300 at the speed of PC2-5700 memory, we saw a considerable jump in this memory's performance. Even when we compared its performance against DDR2-675, DDR2-700,



Corsair ValueSelect PC2-5300 VS512MB667D2

and DDR2-800 modules, Corsair's PC2-5300 was a top performer at 711MHz. It achieved the highest Sandra Int ALU score of 2886. The Float FPU score was an impressive 2894. Although the 3DMark05 score was the lowest (4863) of any memory we tested at 711MHz, a real-world test was far more encouraging. It received the second-highest score in both runs of Doom 3's

timedemo, with frame rates of 75.3fps and 107.2fps. PCMark04 scores were above average with Corsair's ValueSelect PC2-5300 OCed to 711MHz. The System Suite score was 5624 PCMarks, and the Memory score was 6061.

Crucial Ballistix PC2-5300 BL6464-AA664. Next, we tested two of Crucial's individually packaged Ballistix PC2-5300 modules. This 667MHz memory features a gold heatspreader and timings of 4-4-4-10. However, we had to adjust the timings to at least 5-5-5-15 to run our tests with the memory operating at 667MHz.

At 667MHz, we documented test results that were about average. For instance, the Sandra 2005 Memory Benchmark scores were 2777:2834 (Int ALU:Float FPU) and Doom 3 results were 74.6fps and 106fps (almost identical to the frame rates of the Corsair ValueSelect PC2-5300). This memory scored very well on 3DMark05. In fact, only one other module, Corsair's 675MHz xtreme performance PC2-5400, outperformed it when operating at 667MHz. None of the DDR2-667 modules running at 667MHz achieved as high a 3DMark05 score as Crucial's 4887 3DMarks. We found it somewhat surprising that Crucial's Ballistix memory scored low on PCMark04, with a System Suite score of 5581 and a Memory score of 5916.

When we overclocked Crucial's Ballistix PC2-5300 memory to 711MHz by changing the DRAM:CPU ratio to 2:3, it competed much better. It still scored very high in Sandra 2005 (2883:2898, the second-highest scores at 711MHz). The 3DMark05 score improved markedly at 4884, one of the highest 711MHz scores. We were most intrigued, though, by the improvement in PCMark04. Whereas Crucial's RAM scored lower than all but one other kit at 667MHz, when running at 711MHz, the Ballistix PC2-5300 soared above the competition, achieving the highest System Suite score of 5716 PCMarks. The memory score was also impressive, at 6005. We had hoped to test Crucial's RAM at 800MHz, as well, but our PC rebooted during the Sandra 2005 test when we pushed the DRAM:CPU ratio beyond 2:3.

GeIL Value Series DDR2-667 PC2-5300 GX21GB5300DC. We have had

excellent results with GeIL's memory in the past, so we ordered a matched pair of GeIL's Value Series PC2-5300. Unlike Corsair's value-priced memory, which has bare PCBs, GeIL's Value Series modules are equipped with platinum heatspreaders. The memory is rated at timings of 4-4-4-12. Once again, our P5WD2 Premium mobo did not seem to cooperate with such timings, and we had to change the timings to 5-5-5-15. With GeIL's PC2-5300 memory running at 667MHz, our tests returned acceptable but average scores of 2793:2843 in Sandra 2005, 4882 3DMarks, 74.6fps and 106.2fps in Doom 3, 5620 PCMarks in the System Suite, and 5909 in PCMark04's Memory test. We changed the timings to 5-6-6-2 when we upped the frequency of GeIL's PC2-5300 to 711MHz, and its Sandra 2005 scores rose enough (2832:2902) that the RAM achieved a higher Float FPU than any other memory running at 711MHz. Scores were also impressive for 3DMark05 (4886), Doom 3 (75.3fps and 107.1fps), and PCMark04 (System Suite: 5708, Memory test: 6067).

We were most impressed, though, when we set the DRAM:CPU ratio to 3:4 and tested GeIL's DDR2-667 memory at an 800MHz frequency. At this speed, the memory achieved the highest Sandra 2005 Int ALU (3069) and the second-highest Float FPU (3101). Our system hit high frame rates in Doom 3 (75.9fps and 108.6fps) and the highest 800MHz score in PCMark04's Memory test (6222). We were a bit baffled, however, by the 3DMark05 score. At 4865 3DMarks, it was the lowest of any memory we tested at 800MHz.



GeIL DDR2-667 PC2-5300 GX21GB5300DC

When running at 800MHz, GeIL's PC2-5300 RAM not only competed well against other memory operating at 800MHz, it performed well against all the memory we tested, regardless of the frequency at which we tested the other memory. The 3069 Int ALU result in Sandra 2005 was the highest score we achieved with any RAM at any frequency. Our 108.6fps

Eoom 3 frame rate was another all-time high in our tests, as was PCMark's 6222 score in the Memory test. These scores were better than expected for "value" memory.

Mushkin PC2-5300 991379a. Mushkin also produces a matched-pair kit of DDR2-667. Whereas Mushkin's DDR has either blue or black PCBs, the DDR2 series has the more typical green PCBs. The Mushkin PC2-5300 includes a heatspreader, but color varies. The modules we received had black heatspreaders. Mushkin's PC2-5300 currently has latencies of 4-4-4-12.

At 667MHz, Mushkin's memory scored 2509:2611 in Sandra 2005, 4862 in 3DMark05, 5677 in PCMark04's System Suite, and 5860 in PCMark04's Memory test. It also helped our test system achieve frame rates of 74.4fps and 105.5fps in Doom 3. Most of these scores were fairly average. However, Sandra's Int ALU score and the 3DMark05 score were the lowest of all the memory we tested at 667MHz.

At 711MHz, Mushkin's PC2-5300 fared only a little bit better, with Sandra 2005 scores rising to a more acceptable level, but its 5612 PCMarks were the lowest System Suite score of any memory we tested at 711MHz. We also could not achieve stable performance with this memory overclocked to 800MHz. Generally, we have better luck with Mushkin's memory, but the modules we received this time just weren't as stable as ones we've used in the past.

OCZ Technology Performance Series PC2-5400 OCZ26671024PFDC-K. OCZ Technology's Performance Series modules all come with mirrored-copper heatspreaders. The memory has timings of 4-4-4-8 and includes EVP (Extended Voltage Protection), which provides warranty coverage when this memory is operated at voltages ranging within 5% of 2.2V.

This memory was stable at several frequencies. At its rated 667MHz, it achieved 2635:2733 in Sandra 2005's Memory Bandwidth benchmark, 4882 3DMarks, 5646 PCMarks, and a score of 5890 in PCMark04's Memory test. Doom 3 was the only test in which OCZ fell behind the competition, managing frame rates of just 73.6fps and 105.9fps.

At 711MHz, we had to adjust the timings to 5-6-6-2. Sandra scores dropped to

2445:2501, with the Float FPU the lowest of all at 711MHz. Doom 3 frame rates stayed fairly slow, at 74.5fps and 105.9fps. We saw a slight bump in the PCMark04 scores (5679 and 5934). At 711MHz, though, the OCZ PC2-5400 modules was one of just two pairs (the other being PQI's DDR2-667) to reach 4889 3DMarks.

PQI TurboMemory PC2-5400 CM2-X512A-5400UL. The PQI PC2-5400 matched pair we tested had the benchmark scores to show how it outperformed many of the competing modules. These PQI modules have mirrored black copper heatspreaders and latency timings of 4-4-4-12.

At its rated frequency of 667MHz, PQI's memory put up exceptional scores. Sandra 2005 Memory Bandwidth test scored 2894:2923, the highest we recorded at 667MHz. PQI's modules also produced the highest 667MHz frame rate (75.2fps) in the first run of Doom 3. It also produced the second-highest frame rate (106.5fps) in the second run. The PCMark04 System Suite score was 5653, but it was the PCMark04 Memory score that showed the PQI memory's mettle. Its 5986 score was the second-highest in our group at 667MHz.

The PQI modules' performance continued to shine at 711MHz. It achieved the highest 3DMark05 score (tied with OCZ's DDR2-667) of memory operating at 711MHz. PQI also showed its power in Doom 3's timedemo, with 75.5fps and 107.1fps rates. With the PQI memory operating at 711MHz, PCMark04's System Suite hit a score of 5695, and the Memory score was even better, at 6073.

PQI's memory also showed admirable results when OCed to 800MHz. Here, our system hit Sandra 2005 Memory scores of 3065:3088. Among memory tested at 800MHz, only the GeIL PC2-5300's 3069 Int ALU score was higher. Our system achieved an impressive 108.5fps in the second run of Doom 3 with the PQI memory running at 800MHz. Once again, the PQI PC2-5400 pushed the PCMark04 Memory score higher, this time reaching 6220, the second-highest 800MHz DDR2 score.

DDR2-675 (PC2-5400)

We tested four modules designed to operate at 675MHz. Keep in mind that



PQI TurboMemory PC2-5400 PQI25400-1GDB

with such a small variance in rated frequencies between the DDR2-675 and the DDR2-667, it is a good idea to compare the DDR2-675 modules' results with the DDR2-667 modules' scores.

Corsair XMS2 PC2-5400 CM2X512A-5400UL. The PC2-5300 Corsair modules we tested were from the ValueSelect line. However, we chose a matched pair of Corsair XMS2 modules for our PC2-5400 selection. As a member of the XMS2 rather than the ValueSelect series, our XMS2 PC2-5400 memory has black heatspreaders and faster timings of 4-4-4-12. After we ordered our XMS2 PC2-5400 memory, Corsair released PC2-5400 modules with more aggressive timings of 3-3-2-8.

Our P5WD2 Premium's BIOS did not offer an option to operate our memory at 675MHz. We could have achieved this by tweaking the FSB, but we wanted our tests to be as consistent as possible, which meant ensuring that only the memory's frequency changed, not that of the FSB or CPU. For this reason, we chose to test all DDR2-675 modules, including Corsair's PC2-5400, at 667MHz and 711MHz but not 675MHz.

At 667MHz, Corsair's XMS2 PC2-5400 excelled in PCMark04's System Suite, with a score of 5699, the highest score we achieved with any memory at 667MHz. Corsair's XMS2 PC2-5400 scored 5931 in the PCMark04's Memory test, 2646:2708 in Sandra 2005's Memory Bandwidth benchmark, and 4872 in 3DMark05. The 3DMark05 score was a little bit low, but Corsair's memory performed considerably better in Doom 3's timedemo (75fps and 106.5fps), which is a better measure of real-world performance.

When we changed the DRAM:CPU ratio to run Corsair's XMS2 PC2-5400 at 711MHz, benchmark scores dropped considerably. The Sandra 2005 Memory Benchmark (2443:2503), 3DMark05 (4867), Doom 3 (74.5fps and 105.8fps)

The chart on the next page summarizes the results of the tests we performed with each pair of memory modules. We ran Sandra 2005's Memory Bandwidth Benchmark, 3DMark05's Games Tests, Doom 3's timedemo, PCMark04's System Suite, and PCMark04's Memory test. We tested the memory modules at 533MHz, 667MHz, 711MHz, 800MHz, and, if possible, 889MHz. We tried to test the PC2-6400 memory at 1,066MHz as well but could not achieve stable system operation. ▲

results were among the lowest of the memory we tested at 711MHz. The PCMark scores were only slightly more favorable, with 5615 on the System Suite and 5941 on the Memory test. We used timings of 5-6-6-2 at 711MHz, but the change in timings alone does not account for the lower scores. Almost all of the modules we tested required timings of 5-6-6-2 at 711MHz.

Given the lower scores, we didn't expect stability at 800MHz without further tweaking. But once we changed the DRAM:CPU ratio to 3:4, Corsair's XMS2 modules ran at 800MHz without incident. The 3DMark05 score improved to 4902. Other scores were still lower than competing memory set at 800MHz, with scores of 2625:2700 (Sandra 2005's Memory Bandwidth benchmark), 75.5fps (Doom 3, first run), 107.4fps (Doom 3, second run), 5687 (PCMark04 System Suite), and 6056 (PCMark04 Memory). The PCMark04 Memory score was the lowest score of any memory operating at 800MHz.

This memory was stable enough at 889MHz for our system to POST, and our system ran long enough to record Sandra's results of 2894:2942. However, when we tried to run 3DMark05, the system crashed. Increasing the memory voltage did not help the system run stable.

Corsair xtreme performance PC2-5400 TWIN2X1024-5400C4. We tested not one but two pairs of Corsair DDR2-675. The second pair we tested was Corsair's xtreme performance PC2-5400 TWIN-2x1024-5400C4, which features black heatspreaders and timings of 4-4-4-12.

The xtreme performance series PC2-5400 did indeed perform better than the

Rated Frequency	Modules	Settings	DRAM: CPU Ratio	Timings	Sandra 2005 Int ALU
667MHz	Corsair ValueSelect PC2-5300 VS512MB667D2 (x2)	Underclocked to 533MHz 667MHz Overclocked to 711MHz Overclocked to 800MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400)	5-5-5-12 5-5-5-15 5-6-6-2 N/A - System unstable at 800MHz DDR2 frequency	2555 2843 2886 System rebooted
667MHz	Crucial Ballistix PC2-5300 BL6464AA664 (x2)	Underclocked to 533MHz 667MHz Overclocked to 711MHz Overclocked to 800MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400)	5-5-5-12 5-5-5-15 5-6-6-2 N/A - System unstable at 800MHz DDR2 frequency	2592 2777 2883 System rebooted
667MHz	GelL Value Series DDR2-667 PC2-5300 GX21GB5300DC	Underclocked to 533MHz 667MHz Overclocked to 711MHz Overclocked to 800MHz Overclocked to 889MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400) 5:6 (PC2-7100)	5-5-5-12 5-5-5-15 5-6-6-2 5-6-6-2 N/A - System would not POST at 889MHz DDR2 frequency	2581 2793 2832 3069 N/A
667MHz	mushkin PC2-5300 991379a	Underclocked to 533MHz 667MHz Overclocked to 711MHz Overclocked to 800MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400)	4-4-4-12 4-5-5-15 5-6-6-12 N/A - Windows crashed at 800MHz DDR2 frequency	2388 2509 2444 N/A
667MHz	OCZ Technology Performance Series PC2-5400 OCZ26671024PFDC-K	Underclocked to 533MHz 667MHz Overclocked to 711MHz Overclocked to 800MHz Overclocked to 889MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400) 5:6 (PC2-7100)	4-4-4-7 4-5-5-8 5-6-6-2 5-6-6-2 N/A - System would not POST at 889MHz DDR2 frequency	2478 2635 2445 2657 N/A
667MHz	PQI TurboMemory PC2-5400 PQI25400-1GDB	Underclocked to 533MHz 667MHz Overclocked to 711MHz Overclocked to 800MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400)	4-4-4-11 4-5-5-14 5-6-6-2 5-6-6-2	2728 2894 2861 3065
675MHz	Corsair XMS2 PC2-5400 CM2X512A-5400UL	Underclocked to 533MHz Underclocked to 667MHz Overclocked to 711MHz Overclocked to 800MHz Overclocked to 889MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400) 5:6 (PC2-7100)	4-4-4-12 4-4-4-15 5-6-6-2 5-6-6-2 5-6-6-2	2369 2646 2443 2625 2894
675MHz	Corsair xtreme performance XMS2 PC2-5400 TWIN2X1024-5400C4	Underclocked to 533MHz Underclocked to 667MHz Overclocked to 711MHz Overclocked to 800MHz Overclocked to 889MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400) 5:6 (PC2-7100)	4-4-4-12 4-5-5-15 5-6-6-2 5-6-6-2 N/A - System would not POST at 889MHz DDR2 frequency	2705 2880 2843 3056 N/A
675MHz	Kingston HyperX PC2-5400 KH5400D2/512	Underclocked to 533MHz Underclocked to 667MHz Overclocked to 711MHz Overclocked to 800MHz Overclocked to 889MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400) 5:6 (PC2-7100)	5-5-5-12 5-5-5-15 5-6-6-2 5-6-6-2 N/A - System would not POST at 889MHz DDR2 frequency	2198 2528 2421 2621 N/A
675MHz	Wintec Industries AMP-X DDRE Extreme PC2-5400 3AXD2675 (x2)	Underclocked to 533MHz Underclocked to 667MHz Overclocked to 711MHz Overclocked to 800MHz	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400)	4-4-4-12 4-5-5-15 5-6-6-2 N/A - System would not POST at 800MHz DDR2 frequency	2427 2522 2448 N/A
800MHz	Corsair XMS2 PC2-6400 TWIN2X512A-6400	Underclocked to 533MHz Underclocked to 667MHz Underclocked to 711MHz 800MHz Overclocked to 889MHz, increased memory voltage to 1.95V Overclocked to 1,066MHz, increased memory voltage to 1.95V and 2V	1:2 (PC2-4300) 3:5 (PC2-5300) 2:3 (PC2-5700) 3:4 (PC2-6400) 5:6 (PC2-7100) 1:1 (PC2-8000)	5-5-5-12 5-5-5-15 5-6-6-2 5-6-6-2 5-6-6-2 N/A - System would not POST at 1,066MHz DDR2 frequency at either voltage	2217 2522 2452 2596 2868 N/A

Sandra 2005 Float FPU	3DMark05 Games	Doom 3, High 800 x 600, first run	Doom 3, second run	PCMark04 System Suite	PCMark04 Memory
2590	4890	73.5fps	103.8fps	5644	5733
2861	4881	74.7fps	106fps	5611	5922
2894	4863	75.3fps	107.2fps	5624	6061
System rebooted	N/A	N/A	N/A	N/A	N/A
2592	4891	74fps	104.2fps	5621	5745
2834	4887	74.6fps	106fps	5581	5916
2898	4884	74.7fps	107.4fps	5716	6005
System rebooted	N/A	N/A	N/A	N/A	N/A
2588	4893	73.8fps	104fps	5668	5759
2843	4882	74.6fps	106.2fps	5620	5909
2902	4886	75.3fps	107.1fps	5708	6067
3101	4865	75.9fps	108.6fps	5693	6222
N/A	N/A	N/A	N/A	N/A	N/A
2486	4887	74fps	104.8fps	5612	5754
2611	4862	74.4fps	105.5fps	5677	5860
2543	4871	74.7fps	105.8fps	5612	5923
N/A	N/A	N/A	N/A	N/A	N/A
2547	4876	73.7fps	104.9fps	5661	5768
2733	4882	73.6fps	105.9fps	5646	5890
2501	4889	74.5fps	105.9fps	5679	5934
2730	4873	75.7fps	107.4fps	5699	6059
N/A	N/A	N/A	N/A	N/A	N/A
2767	4861	74.5fps	105.8fps	5596	5893
2923	4874	75.2fps	106.5fps	5653	5986
2888	4889	75.5fps	107.1fps	5695	6073
3088	4880	75.6fps	108.5fps	5690	6220
2440	4879	74.1fps	104.9fps	5653	5748
2708	4872	75fps	106.5fps	5699	5931
2503	4867	74.5fps	105.8fps	5615	5941
2700	4902	75.5fps	107.4fps	5687	6056
2942	N/A - 3DMark05 crashed at 889MHz DDR2 frequency	N/A	N/A	N/A	N/A
2746	4889	74.9fps	105.9fps	5626	5893
2922	4893	74.9fps	106.8fps	5662	6011
2902	4884	75.3fps	107.2fps	5613	6083
3102	4869	76.2fps	108.5fps	5732	6194
N/A	N/A	N/A	N/A	N/A	N/A
2276	4871	72.7fps	102.5fps	5525	5610
2570	4879	74fps	104.9fps	5542	5782
2516	4881	74.6fps	105.6fps	5687	5908
2733	4880	75.7fps	107.7fps	5659	6080
N/A	N/A	N/A	N/A	N/A	N/A
2469	4878	74fps	104.7fps	5620	5767
2600	4874	74.4fps	105.8fps	5693	5861
2516	4889	74.5fps	105.5fps	5679	5907
N/A	N/A	N/A	N/A	N/A	N/A
2294	4893	72.8fps	102.7fps	5501	5574
2587	4881	74.1fps	104.8fps	5654	5794
2510	4876	73.5fps	105.8fps	5663	5905
2726	4888	75.6fps	107.7fps	5699	6082
2960	4880	75.9fps	108fps	5639	6135
N/A	N/A	N/A	N/A	N/A	N/A

standard XMS2 PC2-5400 RAM. At 667MHz, it performed very well in Sandra 2005, with 2880 Int ALU and 2922 Float FPU. It led the pack in three tests: 3D-Mark05 (4893), Doom 3's second run (106.8fps), and PCMark04's Memory test (6011). Its other scores were acceptable, as well, with a frame rate of 74.9fps on Doom 3's first run and a System Suite score of 5662 in PCMark04.

The memory still performed well when OCed to 711MHz, at which we got very high Sandra 2005 Memory Bandwidth scores of 2843:2902. Doom 3 frame rates were also high, at 75.3fps and 107.2fps. PCMark04 received mixed results, with the System Suite score of 5613 being one of the lower scores but the 6083 Memory score being the highest 711MHz score.

Corsair's xtreme performance PC2-5400 easily overclocked to 800MHz. At this frequency, it continued to rival the competition, with scores of 3056:3102 (Sandra 2005 Memory Bandwidth), 76.2fps and 108.5fps (Doom 3), 5732 (PCMark04 System Suite), and 6194 (PCMark04 Memory). Only the 3DMark05 score was somewhat low at 4869.

Kingston HyperX PC2-5400 KHX-5400D2/512. Finally, we tested a DDR2 matched pair from one of the most well-known brands, Kingston. Its HyperX PC2-5400 RAM has timings of 4-4-4-10.

At 667MHz, the memory returned disappointing results. The Sandra 2005 scores only reached 2528:2570, and the PC-Mark04 scores were 5542 (System Suite) and 5782 (Memory). These were among the lowest recorded at 667MHz. Doom 3 frame rates were 74fps and 104.9fps, and the 3DMark05 score was 4879.

At 711MHz, Kingston's PC2-5400 scored only 2421:2516 in Sandra's Memory Bandwidth benchmark. It achieved 4881 3DMarks as well as frame rates of 74.6fps and 105.6fps in Doom 3. At 711MHz, PCMark04 returned a System Suite score of 5687 and a Memory score of 5908 (one of the lower Memory scores). At 800MHz, test scores were average, at 2621:2733 (Sandra 2005 Memory Bandwidth), 4880 (3DMark05), 75.7fps and 107.7fps (Doom 3), 5659 (PCMark04 System Suite), and 6080 (PCMark04 Memory).

Wintec Industries AMP-X High Performance PC2-5400 39127282-UA . Wintec Industries manufactures memory primarily for OEMs, but its modules are available through some vendors. We used two 512MB sticks because the dual-channel kits were out of stock. This memory has timings of 4-4-4-10.

This memory produced average results at 667MHz. In Sandra 2005's Memory Bandwidth benchmark, the Wintec RAM had an Int ALU of 2522 and a Float FPU of 2600. 3DMark05 returned a score of 4874, and Doom 3's frame rates were 74.4fps and 105.8fps. The PCMark04 System Suite score was an impressive 5693, and the Memory score was 5861.

When we increased the frequency to 711MHz, 3DMark's score improved to 4889. The RAM still scored fairly low in Doom 3, with frame rates of 74.5fps and 105.5fps. The memory produced a PC-Mark04 System Suite score of 5679 and a Memory score of 5907. Although this score was higher than the score at 667MHz, most of the other RAM showed a more drastic improvement in the Memory score when increased from 667MHz to 711MHz. We could not achieve stable operation at 800MHz.

DDR2-800 (PC2-6400)

Many companies sold 800MHz RAM when we started this issue, but it was hard to find. We only managed to get one pair of DDR2-800 in time to go to press.

Corsair xtreme performance XMS2 PC2-6400 TWIN2X1024A-6400. The last memory we tested was Corsair's xtreme performance XMS2 PC2-6400 TWIN2X-512A-6400, the only 800MHz DDR2 we could receive in time for our testing. Corsair's xtreme performance XMS2 PC2-6400 has timings of 5-5-5-12.

With a DRAM:CPU ratio of 3:5, Corsair's memory was underclocked at 667MHz. It received lower-than-average scores of 2522:2587 in Sandra 2005's Memory Bandwidth benchmark, 5654 in PCMark04's System Suite, and 5794 in PCMark04's Memory test. Our system received 4881 3DMarks and achieved Doom 3 frame rates of 74.1fps and 104.8fps at 667MHz.

We increased the frequency to 711MHz, much closer to the Corsair PC2-6400's intended frequency. Here, Sandra returned scores of 2452:2510, and 3DMark05 gave our system a score of 4876 3DMarks. Doom 3's frame rates stayed nearly the same, at 73.5fps and 105.8fps. The PCMark04's System Suite score only rose to 5663, but the Memory score improved, reaching 5905.

The true test of this memory was how it would perform at its rated frequency of 800MHz. Sandra only reached scores of 2596:2726, but Doom 3's frame rates reached 75.6fps and 107.7fps. We saw improvement in both 3DMark05's score (4888) and in PCMark05's scores (5699 for the System Suite and 6082 for the Memory test).



Corsair XMS2 PC2-6400 TWIN2X512A-6400

At this point, the Corsair PC2-6400 hadn't quite wowed us. We OCed the memory to 889MHz. At this level, our scores jumped to a more impressive level. Our system managed 2868:2960 in Sandra 2005's Memory Bandwidth benchmark, 4880 (in 3DMark05), 75.9fps and 108fps (in Doom 3's timedemo), 5639 (in PCMark04's System Suite), and 6135 (in PCMark04's Memory test). We tried to overclock the memory to 1,066MHz but could not maintain stable operation with this frequency.

Memory Mayhem

There are now many DDR2-667 and DDR2-675 modules from which to choose. The latest DDR2-1000/1066 modules are even available now, although they are currently likely to be on back order. It is evident from the explosion of available DDR2 that the technology is finding its place with PC builders. **CPU**

by Kylee Dickey

Twice As Nice?

Under The Hood Of Current Dual-Core CPUs

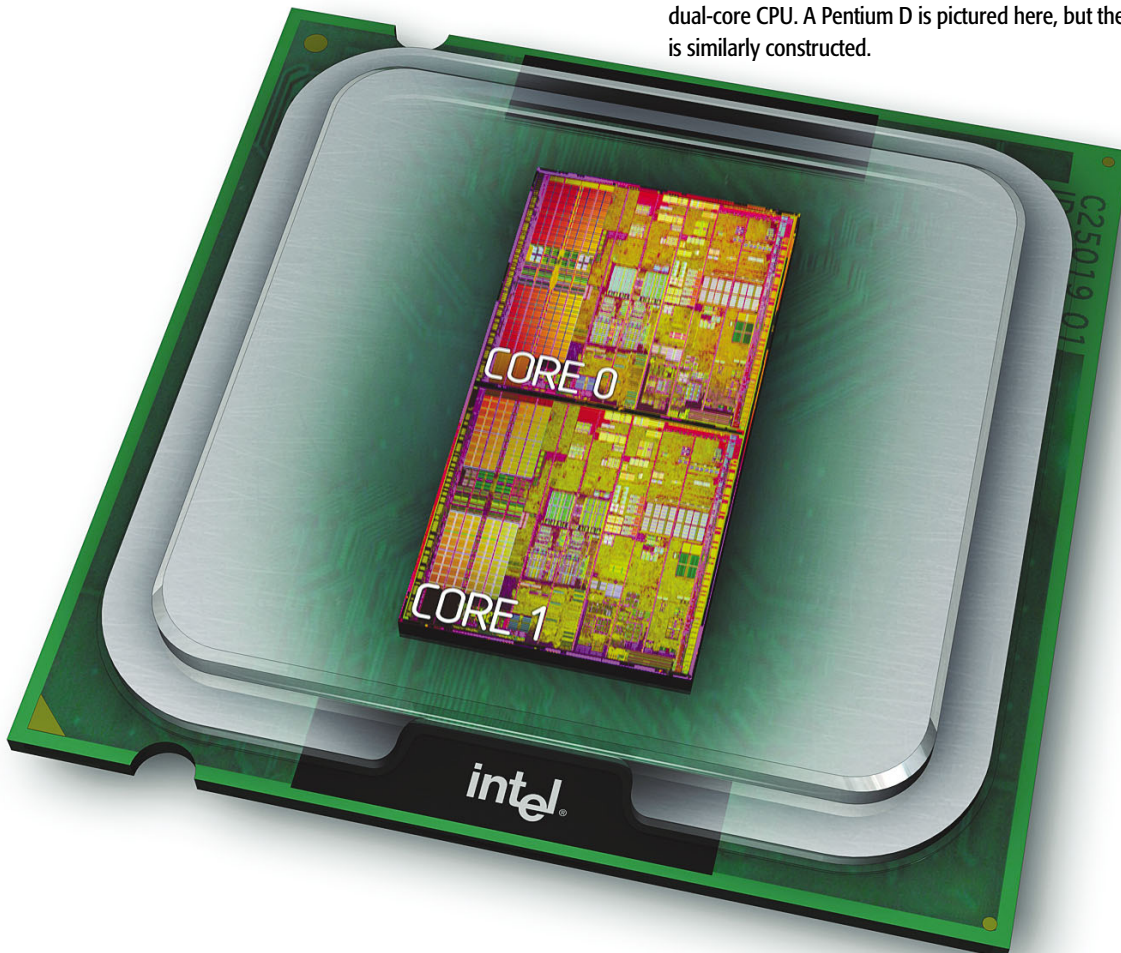
Desktop CPU manufacturers, such as Intel and AMD, have historically increased the clock speeds of their processors to bolster performance. They've made other architectural enhancements to CPU cores, as well, such as retrofitting the base architectures with specialized multimedia instruction sets and making changes to the execution pipeline to achieve a higher IPC (instructions per clock cycle), among other things. And, of course, there have also been advances in I/O technologies. AGP, DDR and DDR2 memory, PCI

Express and HyperTransport, along with a plethora of other platform enhancements, have all contributed to the incremental performance improvements of the personal computer. But through it all, even with the myriad changes made to the PC, most modern systems have always had one thing in common with their ancestral cousins: The processors in virtually all desktop systems were equipped with only a single execution core. But times they are a-changing, and single-core processors are about to become a thing of the past.

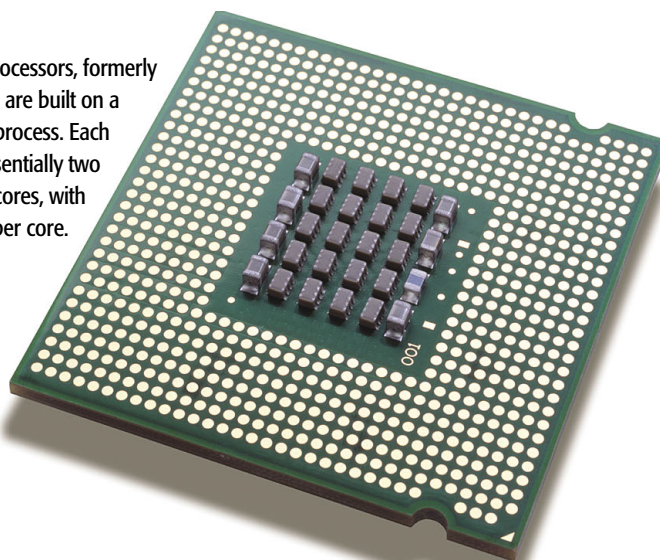
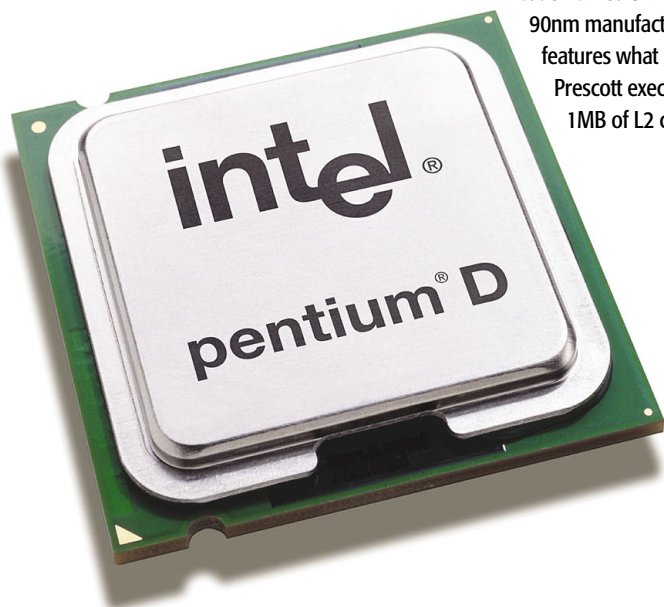
Intel hinted at the future of desktop microprocessors with the introduction of its Hyper-Threading technology a few years back. Hyper-Threading allowed thread-level parallel processing on a single-execution core. That meant that two independent threads could be executed at once for an increase in performance in some circumstances, although each thread had to compete for available processor resources. But Intel's and AMD's latest microprocessors take thread-level parallelism a step further by incorporating dual-execution cores onto a single CPU.

So, what are the advantages of a dual-core processor? Well, to put it simply, having dual execution cores incorporated into a single central processor essentially doubles the amount of resources available to the operating system and

Two execution cores reside under the integrated heat spreader of a dual-core CPU. A Pentium D is pictured here, but the Athlon 64 X2 is similarly constructed.



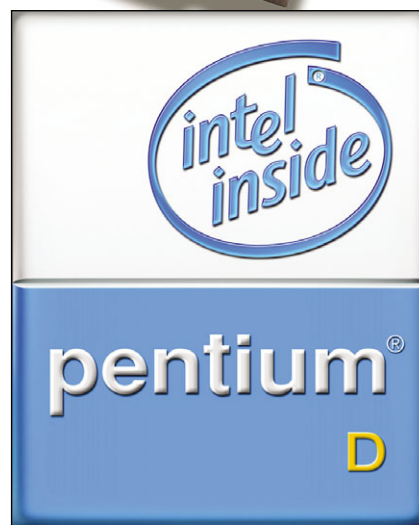
Intel's dual-core Pentium D processors, formerly code-named Smithfield, are built on a 90nm manufacturing process. Each features what are essentially two Prescott execution cores, with 1MB of L2 cache per core.



applications running on the PC. Having dual execution cores offers a theoretical 2x increase in performance at like clock speeds because twice the number of threads can be processed per clock cycle without contention for resources within each core. It's fundamentally similar to having an SMP (symmetric multiprocessing) system, with a matched pair of processors installed. But to take advantage of the resources offered by the second core, the operating system and the applications running on the PC must have been programmed specifically for multithreading.

The good news is Windows NT-based OSes (including Windows XP Professional) and most Linux distributions already benefit from dual-core processors. The list of multi-threaded applications is relatively small, however. To date, most developers haven't focused on delivering multi-threaded apps because there simply hasn't been a large enough demand for them on the desktop. There has been a demand in the enterprise, and with users of specialized animation and image-processing applications, but the general public didn't have the need for multithreaded applications until fairly recently. Now, though, Intel already has a huge

installed base of Hyper-Threading-enabled processors, and both AMD and Intel have released multiple dual-core CPUs. This gives the development community much more incentive to produce applications that will benefit from running on these more powerful processors. Even game developers have begun working on engines that can benefit from dual-core processors.



By The Numbers

To demonstrate the OC-ability of Intel's and AMD's dual-core CPUs, we ran SiSoft SANDRA 2005's CPU arithmetic benchmark on one of each at its stock settings and again while overclocked. By way of comparison, we also included scores for the same test from AMD's single-core Athlon FX-57.

Athlon 64 X2 4800+ (Stock: 2.4GHz)		Athlon 64 X2 4800+ (Overclocked: 2.7GHz)	
Dhrystone ALU – 22395 MIPS		Dhrystone ALU – 25063 MIPS	
Whetstone FPU – 7646 MFLOPS		Whetstone FPU – 8556 MFLOPS	
Whetstone iSSE2 – 9895 MFLOPS		Whetstone iSSE2 – 11077 MFLOPS	
Pentium Extreme Edition 840 (Stock: 3.2GHz)		Pentium Extreme Edition 840 (Overclocked: 3.52GHz)	
Dhrystone ALU – 19120 MIPS		Dhrystone ALU – 20898 MIPS	
Whetstone FPU – 7947 MFLOPS		Whetstone FPU – 8709 MFLOPS	
Whetstone iSSE2 – 13286 MFLOPS		Whetstone iSSE2 – 14548 MFLOPS	
Athlon FX-57 (Stock – 2.8GHz)			
Dhrystone ALU – 13052 MIPS			
Whetstone FPU – 4456 MFLOPS			
Whetstone iSSE2 – 5769 MFLOPS			

Overclocking x 2

When Intel and AMD initially announced that they planned to introduce dual-core processors, the PC enthusiast community was concerned that the increased complexity of dual-core CPUs would make them much harder to overclock. Rumors circulated that claimed dual-core processors could even be “clock-locked” to thwart any overclocking attempts altogether. Thankfully, neither of these things turned out to be the case, but concern that overclocking dual-core CPUs might be harder has persisted, thanks in particular to these CPUs’ increased power requirements and thermal output. We’re happy to report, however, that overclocking a dual-core CPU is not only possible, but it’s just as easy as overclocking a single-core CPU, provided you have the right motherboard, adequate cooling, and a quality power supply.

During some recent testing in the lab, we were able to overclock an Athlon 64 X2 4800+ well above its default speed, using nothing more than the included stock AMD heatsink and fan. An Athlon 64 X2 4800+’s default clock speed is 2.4GHz, which is derived by multiplying 12 (the CPU’s default multiplier) by its default base HT clock speed of 200MHz. But by doing nothing more than raising the base HT clock speed to 225MHz, we

were able to take our particular CPU all the way up to an impressive 2.7GHz (12x 225MHz), a 12.5% increase in clock speed. We would like to note that we did this at stock voltage, so with an increased core voltage and more exotic cooling, you can expect even higher overlocks with AMD’s initial dual-core offerings. While it was overclocked to 2.7GHz, we also monitored our Athlon 64 X2 4800+’s temperature and found that even when running under a full load for an extended period with 100% CPU utilization, its temperature never broke the 122°F (50°C) mark.

Intel’s first batch of dual-core processors also proved to be competent overclockers, but they definitely require more coaxing. While testing a Pentium Extreme Edition 840 processor recently with the stock Intel heatsink and fan, we were only able to overclock the CPU to approximately 3.5GHz, 300MHz over its default speed, or a clock speed increase of approximately 9%. At 3.5GHz, though, the chip ran excessively hot, consistently breaking 158°F (70°C) under load. When using more exotic cooling methods though, such as water or vapor phase-change cooling for example, Pentium EE 840 processors can usually hit much higher overlocks, somewhere in the range of 3.7GHz to 3.9GHz. ▲

Intel’s Initial Offerings

The first batch of dual-core processors from Intel come in two flavors, the Pentium D and the Pentium Extreme Edition 840—note that Intel has dropped the 4 from its dual-core brand names. Pentium D processors basically consist of two 90nm Prescott cores, each with 1MB of L2 cache, running at various clock speeds up to 3.2GHz. The Pentium Extreme Edition 840 also sports a pair of Prescott cores, each with 1MB of L2 cache and running at 3.2GHz, but with Hyper-Threading enabled in each core; in the mainstream Pentium D processors, Hyper-Threading

is disabled. As such, the Pentium EE 840 is recognized as four virtual processors by the operating system and can process four individual threads simultaneously. And although it’s clocked significantly lower than some other high-end P4 processors, in certain scenarios, such as 3D rendering or video encoding, the Pentium EE 840 is measurably faster than its single-cored brethren.

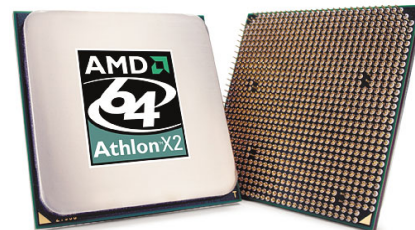
Intel’s dual-core Pentium D and Pentium Extreme Edition processors require motherboards with LGA775 sockets that are based on compatible chipsets, such as Intel’s own 955X and 945G or NVIDIA’s excellent nForce4 Intel Edition.

As of press time, Pentium D processors were available in clock speeds from 2.8GHz to 3.2GHz, with prices ranging from about \$240 for the Pentium D 820 to almost \$1,000 for the top-of-the-line Pentium EE 840.

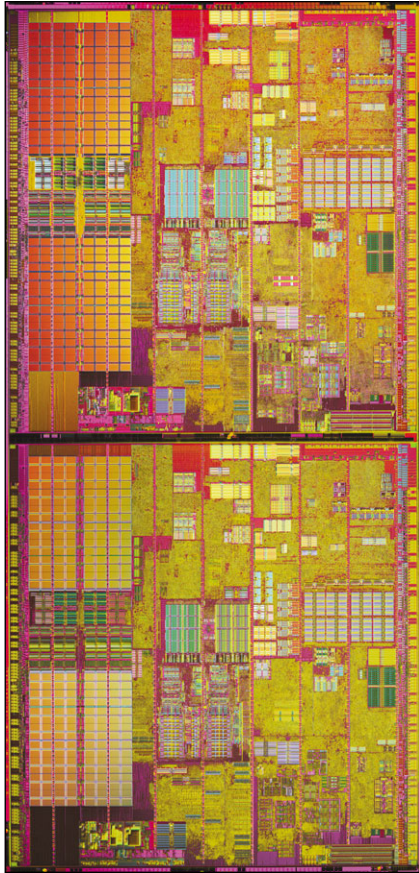
AMD Ups The Ante

AMD’s initial dual-core offerings are fundamentally similar to Intel’s. AMD’s Athlon 64 X2 processors are also available in two configurations. The Athlon 64 X2 4800+ and 4400+ run at 2.4GHz and 2.2GHz, respectively, and consist of two cores, each with 1MB of L2 cache. The Athlon 64 X2 4600+ and 4200+ processors run at the same 2.4GHz and 2.2GHz clock speeds, but feature only 512KB of L2 cache per execution core.

A big advantage for the Athlon 64 X2 processors is that they will work with virtually any socket 939 motherboard. The only caveat is that the motherboard will likely need a BIOS upgrade to support an Athlon 64 X2. Because existing owners of socket 939 motherboards can easily upgrade to a



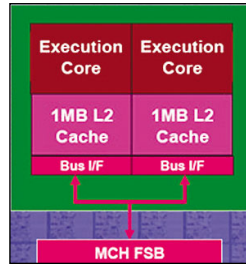
AMD Athlon X2 processors have either dual cores with 1MB of L2 cache or dual cores with 512KB of L2 cache.



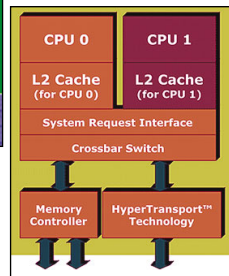
Intel's Smithfield core, used in the Pentium D and Pentium Extreme Edition 840 processors, comprises more than 230 million transistors, and the die is approximately 206mm² in size.

dual-core processor, there is some cost savings, due to the fact that upgrading won't require new RAM and might not require a new video card, but AMD's price scale is tipped a little more to the high end. Athlon 64 X2 processors range in price from \$515 for the 4200+ all the way up to about \$1,100 for the flagship 4800+.

There are some differences in the way Intel's and AMD's processors function, however. Intel's current dual-core processors, and their next-gen 65nm dual-Presler core processors for that matter, require a traditional northbridge with an integrated memory controller. This means that any core-to-core communications have to be done over the frontside bus, which comes at a performance penalty. AMD's Athlon 64 X2 processors don't suffer from this



Each execution core in a Pentium D or Pentium Extreme Edition 840 CPU has its own 1MB of L2 cache but has to share a single amount of available memory bandwidth.



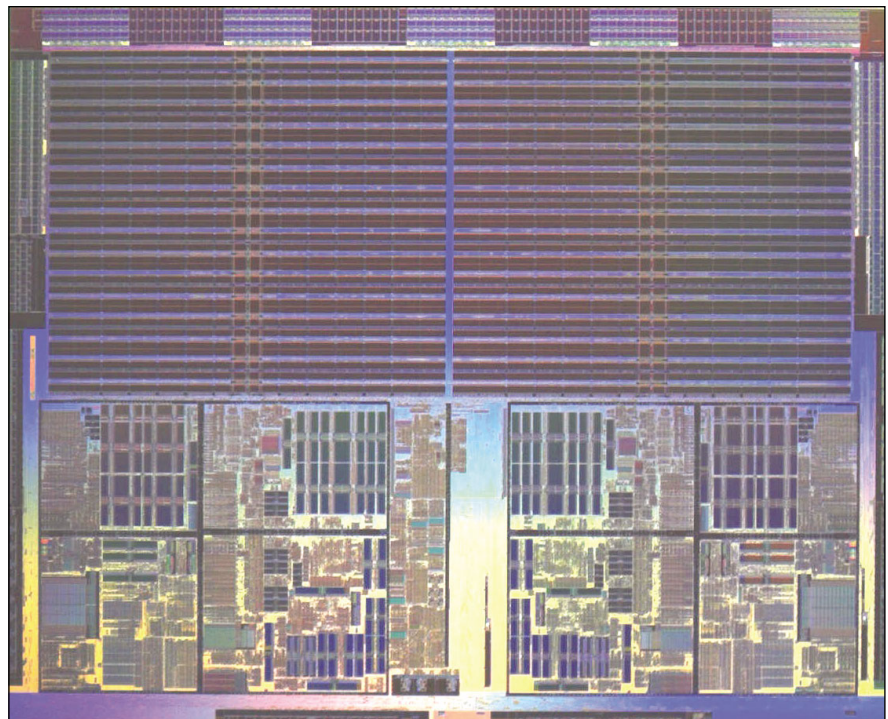
Each of the Athlon X2's execution cores sends a request to the on-die System Request Interface; when resources are available, the request moves on to the appropriate core. This is fundamentally similar to Intel's approach, but AMD's processors handle the process without having to send any data off of the CPU, thanks to its on-die memory controller.

limitation because their memory controller is incorporated into the processor's die. Whereas the Pentium D will have to send some data off and then wait for its return, the Athlon 64 X2 does not. Each of the X2's execution cores will instead send a request to its proprietary on-die System Request Interface, and when resources are available, the request will be sent to the available core. This is similar to Intel's approach, but AMD's processors handle the entire process without having any data leave the confines of the CPU.

Dual-Core Unbound

Intel's and AMD's current dual-core architectures also have to contend with one common shortcoming. Both architectures must share the total amount of system memory bandwidth available with each processor core. This situation exists to maintain compatibility with current platforms, but it will probably be remedied in the future when both companies move to newer sockets and use faster memory technologies. **CPU**

by Marco Chiappetta



AMD's Toledo core, which is at the heart of its Athlon 64 X2 processors, is made up of more than 233 million transistors with an approximate die size of just over 199mm².



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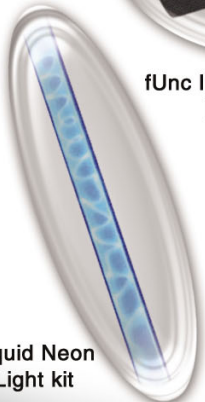
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Clocking Corner

Make The Most Of Your Megahertz

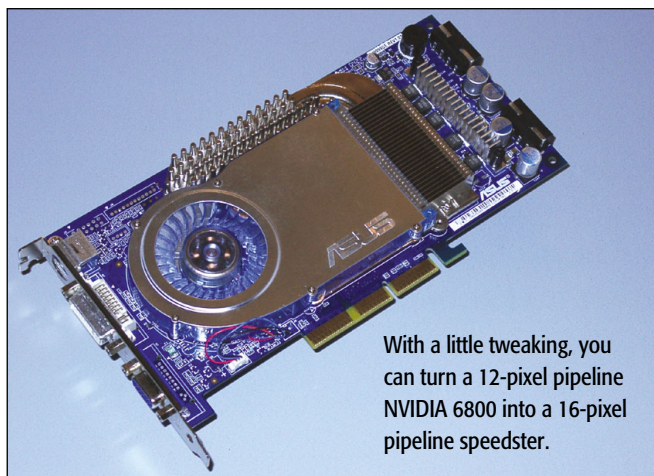
Over the years, an increasing number of computer enthusiasts have used various techniques to get more performance from their gear. Today, overclocking is built into most new hardware designs, from high-performance motherboards to graphics cards and memory. Our goal is to suggest specific pointers for casual users looking to earn their overclocking stripes while offering advanced tips for seasoned veterans. As always, there is an inherent risk to pushing computer hardware beyond its limits, but with a more thorough understanding of the task at hand, the effort can be rewarding. Keep in mind that overclocking voids virtually every warranty available, so tread lightly, use caution, and have fun.

Q Can a GeForce 6800 be unlocked so all pixel pipes and vertex shaders are enabled?

A The answer is both yes and no. The AGP GeForce 6800 is manufactured with 16 pixel pipes and six vertex shaders, with four pixel pipes and one vertex shader disabled in the BIOS. Recently, it's been discovered that the 12-pixel Pipeline GeForce 6800 could be unlocked to a full 16 pixel pipes and six vertex shaders using a simple software

modification. It reverses the BIOS settings, unlocking the full potential of the card. The PCI Express version is physically manufactured with only 12 pixel pipes, so the BIOS changes won't work.

To start, download RivaTuner v15.5 from Guru3D.com. Once installed, go to the Main tab and click Customize under Target Adapter. Choose the image of the video card to bring up the Low-level System Tweaks tab. Next, click the NVStrap driver tab and click the Install button to enable all settings. Now choose Custom under Graphics Processor Configuration and check Allow Enabling Hardware Masked Units. Click Customize, and you will see a list of Bit Fields/Bit Masks. Look for the two that have Yes listed under HW Masked. Place a check mark next to each of these, typically bit 00 and bit 11, and click OK. Now go back into this section, and the previously disabled pixel pipes and vertex shaders should appear enabled. If not, reboot to enable them. If they are enabled, you now have a GeForce 6800 with 16 pixel pipes and six vertex shaders. Try a few games and see if there are any visual anomalies. If you experience no artifacts in the games, your experiment was a success, and you can now try overclocking the card to Ultra speeds. If you see



With a little tweaking, you can turn a 12-pixel pipeline NVIDIA 6800 into a 16-pixel pipeline speedster.

degradation in image quality or artifacts, try disabling the vertex shader to see if it clears up. If not, or if the Bit Fields still say disabled, your card is not suited to this software modification, and you should return all changes back to the default settings.

Q I have a Pentium 4 530 and MSI 915P Neo2 motherboard. Every time I raise the FSB, the system locks at 220MHz and won't go higher. What am I doing wrong?

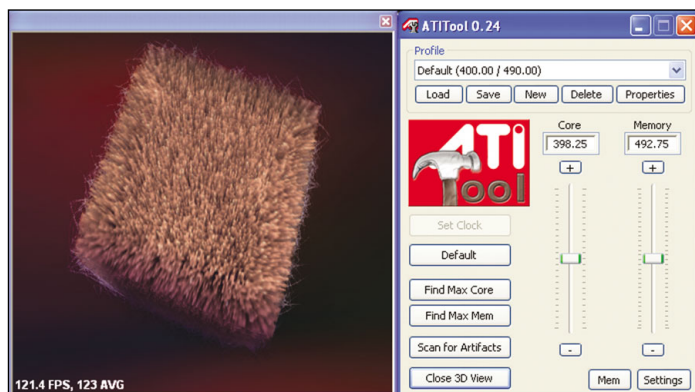
A I recommend locking your memory to 400MHz to isolate your overclocking to the processor and motherboard. Now try raising your FSB. As long as you have sufficient cooling, you should be able to push the FSB past 250MHz, increasing the CPU from 3GHz to 3.7GHz and beyond. If you're successful, this indicates that the FSB was probably pushing your memory beyond its capability. If your memory frequency was set for 533MHz, a 220FSB would increase the memory to 586MHz. By setting it to 400MHz, an FSB of 250MHz would increase the memory to 500MHz, which may be more suited for your particular DIMMs.

Q What are the best memory timings for my ASUS A7N8X Deluxe motherboard with 512MB of Kingston HyperX PC3500 DDR Memory?

A Those modules are rated to run at 434MHz with 2-3-3-8 timings. Your board limits peak memory settings to 400MHz, so there is a fair amount of headroom for overclocking. In fact, you should be able to raise the FSB past 217MHz before you'll need to consider relaxing the timings. However, try increasing the voltage to 2.7V or 2.8V first and you'll find you can go quite a bit higher before having to back off the timings to 2.5-4-4-8.

Q Is it true that I can overclock my AMD Socket A system by installing a mobile processor?

A Yes, this is true, and installing a mobile CPU can yield great overclocking potential. After AMD started locking its Barton core processors,



You can crank up your Radeon 9800 Pro's VPU and memory speeds with the ATITool utility.

some crafty overclockers figured out that the Athlon XP-M was fully unlocked because it's a necessity for laptops to throttle the speed down to reduce power. Additionally, these chips proved to be excellent overclockers because they are designed to run at lower wattage than their desktop counterparts. Because the Athlon XP-M has the same Socket A packaging as the Athlon XP, installation is simple. The most you'll need to do is make sure you have the latest BIOS for your system so the processor is recognized.

Q My Athlon 64 lets me lower the multiplier, but not raise it. What good is that?

A Actually, that can be very useful when overclocking your system. Many users tend to focus solely on increasing their CPU speed, when the goal is to increase overall system performance. By lowering the CPU multiplier setting (remember, the Athlon 64 doesn't have a multiplier), you can increase your FSB while keeping the CPU within operating range. This means that if you have high-speed memory and a motherboard that can hit a high FSB, you can significantly improve your system's overall performance, including the CPU, memory, and system bus.

Q What utility should I use if I want to overclock my Radeon 9800 Pro, and what peak speeds can I expect?

A One of my favorite utilities for overclocking ATI cards is ATITool (www.techpowerup.com/atitool). This is a great free utility that lets you set

overclocking based on 2D and 3D settings and can test the card for artifacts after you overclock it. Your Radeon 9800 Pro runs at 380MHz (VPU) and 350MHz (memory - 700MHz DDR). Although overclocking results can vary widely depending on the environment, you should be able to approach 425MHz for the VPU, and the memory may be able to hit around 400MHz. These are estimates that you may not be able to reach or may even exceed. The main thing is to take baby steps and maintain good airflow around the card.

Q When I raise the FSB of my DFI NF2 Ultra Infinity system, the machine takes several minutes to boot. Why is this happening?

A First, make sure your memory is rated to handle the higher FSB speed. If your increased FSB is pushing your memory beyond its range, you will see strange things happening, such as BSODs, erratic booting, and even data corruption. If the memory is still running within its rated speeds, try increasing its voltage in the BIOS. If all else fails, try swapping the DIMMs with another set and see if it makes a difference. If the problem goes away, the issue is with the memory. Either it's not able to handle the higher speeds or it may be defective. Try running a comprehensive MEMTEST and see if any errors appear in the results. If any errors are reported, you should be able to RMA the DIMMs, as most name brand memory sticks carry lifetime warranties.

Q Should I use a Windows-based utility to overclock my computer or go through the BIOS?

A Most enthusiast-grade motherboard manufacturers offer their own custom overclocking utilities, but I prefer to work with the BIOS. Most motherboards let you access the BIOS by pressing the DELETE key during POST and often have a special menu dedicated to overclocking settings. These settings are typically more comprehensive and work more consistently than Windows-based overclocking tools. Windows-based utilities tend to lack memory divider options and voltage settings, limiting their effectiveness, but can be useful when BIOS options are limited.

Q Is there a way to get more voltage to my DDR memory than the BIOS offers?

A Serious enthusiasts like to perform a VTT (Tracking Termination Voltage) modification, physically altering the motherboard using a soldering iron. A less risky method is to use an ingenious device from OCZ called the OCZ DDR Booster. This device occupies a spare DIMM slot and can push DDR voltage up to 3.9v. The unit also conditions the voltage with OCZ's innovative Power Clean technology, which improves overall operating conditions and can aid in reaching higher overclocking results. Check it out at www.ocz.com.

Q What is the fastest DDR2 memory I can use for overclocking?

A Initially, DDR2 came with higher clock speeds than DDR, but higher latency hampered performance improvements. Today, DDR2 latencies have dropped, and frequencies have increased, yielding higher performance. Corsair, Mushkin, OCZ, and others now offer DDR2 PC5400 RAM, which runs at low latencies while operating at a frequency of 675MHz. OCZ offers the fastest modules (DDR2 PC8000) that run at 1,000MHz, while Corsair offers PC6400 RAM at 800MHz. If your motherboard will push into the 1,000MHz range, I would opt for the PC8000. Otherwise, PC5400 is an excellent choice. **CPU**

by Jeff Bouton

A/C For Your HDD

Hard Drive Coolers, Head To Head

You're covered. Or so you think.

You've worked out the cooling for your computer's processor and video card and you're pretty confident that the case fans you've picked out will keep enough air moving through the system to keep the northbridge and MOSFETs in line. But, depending on the rest of your components, you might be neglecting a few hot spots.

One such heat source is your hard drive. If you're like most enthusiasts, you have a 7,200rpm or 10,000rpm unit in your PC or workstation. Server admins may have SCSI, SAS, or Fibre Channel drives running at 15,000rpm. Even with fluid dynamic bearings (FDBs), the faster a hard drive spins its hard disks, the more heat it produces. Also, the silicon chips running the drive's controller, read channel, and occasionally interface bridge functions do their share to heat things up.

The best medicine to keep a drive alive is to keep it cool—even more so than isolating it from excessive vibration, physical bumps, and power surges. Different materials expand at different rates as they get

hotter, so the aluminum or glass platters in a drive will grow a little faster or slower than the spindle hub or motor shaft, for example. Room for expansion is engineered into every drive, but too much heat for too long can push bearings and other parts ever closer to outright failure.

If you don't believe us, put a 15,000rpm SCSI drive in an uncooled plastic drive enclosure and see how long it survives. Prolonged heat buildup is to your hard drive what a steady diet of junk food is to documentarians.

Many computer cases let you mount an 80mm or 92mm intake fan in front of the 3.5-inch hard drive cage. Take advantage of this provision if it's available. If it isn't, you should think about using one of the many drive coolers on the market. Here's a look at six we found interesting.

How We Tested

We couldn't test how long a particular hard drive would last with good cooling, but we could keep track of a drive's surface temperatures with every cooler we tried. We used a Thermaltake Hardcano 12's thermal probes to chart temps on the drive's side and spindle area (top or

bottom, as available), both at idle and during a run of the IOMeter benchmark utility. IOMeter can give the read channel logic and head armature more of a workout than sequential read/write benchmarks, so it made a good stressor for our purposes.

Our test drive was a Maxtor Diamond-Max Plus 9 SATA, model 6Y080M0, with a capacity of 80GB. This 7,200rpm/8MB cache drive doesn't run as hot as a 10,000rpm Western Digital Raptor or a 15,000rpm server drive, but it does have the same spindle speed and general heat output as most enthusiast's drives. As the majority of our coolers required a 5.25-inch drive bay for installation, we placed the drive in a big bay with no direct fan exposure for our tests. For our bare drive control test, we mounted the drive with common cadmium-plated steel brackets.

Our computer's case was a Lian-Li PC-61 aluminum unit with all panels in place. We ran only two of its 80mm fans, one in the lower front and one at the upper rear, because most users' computer cases probably wouldn't have the four fans Lian-Li gave the PC-61. Some other heat sources in our system included a single-channel Athlon 64 2800+, 1GB (2x512MB) of PC3200 DDR, and a VIA K8T800/VT8237 chipset on an Epox EP-8HDA3+ board.

Test Temperatures

Hotcha! Without any cooling, our hard drive was running a fever. Here's how our various HDD coolers panned out. A Hardcano 12's thermal probes reported the temperatures from the spindle and side of our 7,200rpm Maxtor hard drive at idle and under an IOMeter benchmarking load. The probes were attached away from direct airflow. Temps are in degrees Celsius. Idle temps are after 10 minutes powered on. Spindle temps are as measured from the top or bottom of the drive, as allowed by each cooler.

	Spindle, idle	Spindle, load	Side, idle	Side, load	Notes
Bare hard drive	37.5	38	36	36.5	
Aerocool HB-101	26.7	27.5	N/A	N/A	Fanless
CoolerMaster LHD-V07 CoolDrive Lite	25.5	26.3	29	30	
Just Cooler HD-600	29	29	31	31.5	
Vantec HCP5252	29.3	29.7	32	32.5	
Vantec VTX-COI-BK					
Vortex	27	27.5	30.5	31	High fan setting
Zalman ZM-2HC2	29	30.5	N/A	N/A	Fanless

Aerocool HB-101 Hard Beat Series Fanless HDD

\$49.99 • www.frozenscpu.com/hdc-29.html



This fanless wonder has "superconductor tubes," or so its package claims. Um, somehow we doubt that part. If the HB-101's glorified heatpipes really



could superconduct at room temperature, we imagine that the Taiwanese company would have the rest of the world's undivided attention.

Anyway, the package this cooler comes in is the welded-plastic kind, designed to put your extremities at maximum risk as you attempt to cut it open. After our harrowing but bloodless coolerectomy, we took stock of the heavy metal and other goodies inside the plastic shell.

Half of the HB-101 is two side blocks that fit between the hard drive and the walls of a 5.25-inch bay. The blocks are solid bars of aluminum, apparently extruded with four polygonal tunnels running lengthwise through each. These add surface area, which means a little extra thermal dispersion.

The other part of the HB-101 is a grille of fins composed of nickel-plated aluminum stampings. Like a car radiator's fins, these stampings are thin and fragile. Plan on straightening the ones you bent while removing the assembly from the blister pack. Four heatpipes run through the grille. The ends of these pipes clamp into channels in the side blocks, aided by an included syringe of silverish thermal compound.

Like the Zalman ZM-2HC2 below, this Aerocool draws heat from the sides of a drive, not the top or bottom. An HDD with exposed cast aluminum on its sides, like our Maxtor, should work better with a cooler like this than a plastic-clad drive. Of

course, both fanless coolers in this roundup would really benefit from direct airflow from outside the case, something not generally found near 5.25-inch drive bays in most ATX cases.

Compared to the Zalman, the HB-101's fins gave it a slight cooling edge, despite the former having nearly three times the heatpipes. On the other hand, neither

design addresses the heat dissipated by the spindle motor, as well as the silicon chips on the underside of most drives. Nor does the Aerocool dampen vibrations like the Zalman does, although it should pass heat more readily into the metal of the drive bay. In fact, the Aerocool proved the most effective of the non-fresh-air coolers we tested, even turning in better numbers than several products with fans.

Aerocool's installation guide includes color photos, yet it only conveys about half the information you need to assemble the unit. Notable omissions: The side blocks' recessed holes must face outward; you use the long screws to secure the cooler to the drive; and you must attach the side blocks to the drive first to make everything fit properly.

In the end, the bulk and weight of the Aerocool may be a deal-killer for many users, as might its high price. Less expensive, more effective, and virtually as quiet is the...

CoolerMaster LHD-V07 CoolDrive Lite

\$39.99 •

www.frozcncpu.com/hdc-33.html?id=cciaGsvu



This is one of two 5.25-inch-bay-mounted drive enclosures in this roundup. The other is

the Vantec Vortex below. Because they bring in outside air to cool a drive, coolers like these have an edge over other types. However, the CoolDrive Lite won our favor for more reasons than this.

The LHD-V07 uses a small, conventional fan with straight blades. It lies down in the shell so it can be a little bigger in diameter than could a vertical blower. The fan draws air through a dust filter made of plastic mesh. However, the filter isn't removable and would be difficult, at best, to try to clean.

We bolted our hard drive to the CoolDrive's bottom section, a finned aluminum tray, through compressible, soft rubber grommets. These absorb vibration. CoolerMaster provides a tacky thermal mat that fits between the tray and the bottom of the drive. The instructions don't say anything about removing the transparent plastic sheets that protect the bottom pad before assembly, but you should. A different type of thermal pad is preinstalled under the top panel of the CoolDrive to absorb heat through the top of the drive, but this pad on our sample didn't seem to have a similar protective sheet. We think that these pads, which mate large swathes of drive surface area to aluminum structure, are instrumental in the CoolDrive Lite's effectiveness.

Because the cooler sandwiches the hard drive top to bottom, the airflow from the fresh-air intake fan forks around both sides and into the computer case. The outer surfaces of the CoolDrive's upper shell aren't finned like the bottom tray, but they are lined with shallow grooves for a small gain in radiation area. The



effects of this combination were apparent in our testing. The CoolDrive Lite posted the lowest temps, whether at idle or under load, although some other hard drive coolers were slightly better at keeping the delta small between the two.

The CoolDrive Lite doesn't have the built-in LED and temperature probe of the Vantec Vortex. Then again, it doesn't sound like a rototiller, either. In fact, it was silent to our ears, at least as compared to the rest of the fans in our test PC. The CoolDrive Lite is easily the best cooler of this bunch.

Just Cooler HD-600 H.D.D. Cooler

\$13 • www.frozencpu.com/hdc-03.html



The Just Cooler HD-600 is the only cooler here that fits in a 3.5-inch bay. It's very thin—only 11mm thick—with a quiet, 54mm fan good for 18cfm past the hottest part of a hard drive, namely the exposed PCB. It's small enough to fit between multiple drives in a 3.5-inch bay or rack and cheap enough that you might consider buying one for every drive you own.

Just Cooler made the HD-600 very light. It's basically an anodized aluminum plate with a plastic fan mount/shroud attached to it with flanged tabs. We imagine there's some potential for annoying vibration in such a design, but ours didn't make any noise. Like the other coolers' fans, the HD-600's gets its power through a Molex 4-pin pass-through adapter.

In short, the Just Cooler HD-600 is a cheap and easy add-on. It's quiet and



light as a feather. It isn't the most effective cooler, but it does keep drive temps near their idle baselines. . . although the temps are still dependent on the temperature inside the case.

Vantec HCP5252 HDD Cooler

\$20 • www.frozencpu.com/hdc-06.html



We picked up this 5.25-inch drive bay cooler because the 3.5-inch model was out of stock. Because it was the only hard drive cooler with dual fans, we expected more performance from it. It was the first of two surprising disappointments from Vantec.

Both 7-bladed, 3,800rpm fans had very curved vanes for quiet efficiency. Like a CPU heatsink's blower, their airflow was directed at the hot object strapped to them. They blew directly up at the drive's PCB and underside. The heated air could only escape through two slotted channels running the length of the tray, which seemed constrictive, at least to our inexperienced eyes. It also seemed as if this design would tend to recycle the hot air it expelled.

This cooler's plastic tray doubles as a 5.25-inch drive bay mount, thanks to eight threaded metal inserts. Of course, plastic doesn't conduct heat into a drive bay's walls nearly as well as two cheap steel brackets would, and perhaps that was why the \$13 Just Cooler came out ahead of this Vantec.

Our HCP5252 came with ball-bearing fan motors; there's another edition with sleeved units instead. The two motors share a 4-pin Molex passthrough plug. All screws were included, a feature common to all the cooler kits we bought. This is a complete kit for mounting a hard drive in a big bay and turning some fans on it at the same time, but it wouldn't be our top choice.

Vantec VTX-COI-BK Vortex Hard Drive Cooling S

\$39 • www.frozencpu.com/hdc-19.html

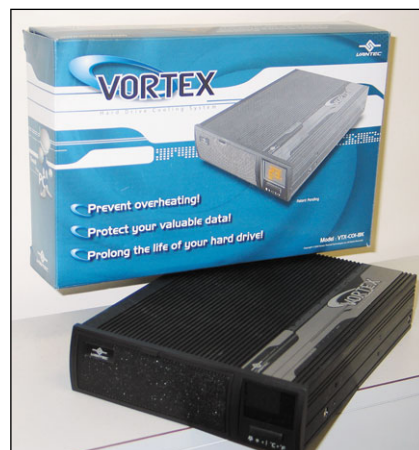


Like the CoolerMaster CoolDrive Lite, the Vortex is another drive enclosure that brings in fresh air from outside the case. It's filtered, good-looking, and apparently well-made, apart from the most important part: the fan.

On the Vortex's sharp-looking frontispiece reside a temperature LED and a metal intake grate that snaps open and shut. The LED is connected to a standard temp probe, which comes with two squares of mounting tape. Inside the grate is a black, foam air filter (two spares come with the unit).

Inside the enclosure and to one side are four L-shaped rubber feet ready to cradle a hard drive. These simultaneously allow airflow under the drive and attenuate vibrations that would manifest themselves as case noise.

Speaking of noise, our unit's fan motor wasn't mounted very well. On paper,



Vantec's Crossflow Blower is a great idea for this application. In practice, however, the long, cylindrical blade unit vibrated and moaned, although we double-checked that our assembly procedure hadn't introduced any wires or structures into its path. On the fan's high setting, the throbbing sound drove us to distraction.

We could lessen the din by tugging on the motor's wires, which seemed to straighten the noticeably loose assembly. Unfortunately, the moment we let go of the wires, the lawnmower racket resumed. The clamor was enough to make us worry about the vibrations possibly causing the drive's error rate to climb.

The fan's low setting suppressed the nastiest parts of the noise, but a low whine of air forced through irregular passages remained. One of our deskmates, who had recently escaped an Escort SX2, remarked, "I didn't know you could get Ford parts for a computer."

A quick glance at reviews on the Web indicates that we probably got a lemon, or at least a unit that was damaged in transit. We traded it for a replacement unit that sounded much better, although the high and low fan settings merely distinguished between two different pitches of howling. \$39 in this category should buy a more foolproof design, so we'd advise against succumbing to the pull of this Vortex.

Zalman ZM-2HC2 Heatpipe HDD Cooler

\$34 • www.frozencpu.com/hdc-22.html



We couldn't wait to try out this fanless cooler, mainly because its heatpipe lattice

and chunky aluminum side blocks made it the most fabulous looking of the group. It did an OK job, but it really needs to be mounted in a case with good ventilation to live up to its potential.

The Zalman fits over the top of a drive, but it only makes contact along the sides. You could mount it underneath, but the contact area between the sides of the drive and the cooler would be reduced by half. Although it was a struggle to get this cooler on and especially off our Maxtor drive, we found out how easy it was to bend one of the heatpipes. We were luckily able to correct our blunder without any ill effects, but you should consider this a cautionary tale.

The ZM-2HC2 doesn't come into direct contact with the drive bay. Instead, Zalman provides rubber spacers with male and female threaded metal inserts to reduce vibration. The company also throws in a ground wire to keep the computer case and hard drive neutral to each other, although this was tricky to install in our drive bay. Finally, there are a couple of adhesive templates that can help you drill holes in the right spots, should you want to mount your drive in a more convenient location.

Despite low initial temperatures, the ZM-2HC2 allowed our drive to heat up more than other coolers. Of course, we should point out that the fanless Zalman will be much more effective on a hard



drive with exposed aluminum on the sides, like our Maxtor, than one with a plastic shell.

Beat The Heat

For our money, the best pick of this litter is the CoolerMaster CoolDrive Lite. In general, any enclosure-style design that imports air from outside the case will keep your drive the happiest. A near-silent fan in a cooler like this can chill a 7,200rpm drive just fine.

As for other types of coolers, remember that if your case fans aren't moving enough fresh air through your computer, it's going to make your hard drive cooler's job that much harder. Positive ventilation is not only good for your drive, but for the rest of your expensive hardware, too. **CPU**

by Marty Sems

Cooler Features

Regular or cylindrical fan? Or no fan at all? Here are the specs we could find for our rowdy gang of hard drive coolers.

	Fans	RPM	CFM	Noise	Comments
Aerocool HB-101	n/a (4 heatpipes)	N/A	N/A	silent	Very heavy; fragile fins
CoolerMaster LHD-V07 CoolDrive Lite	1 x 44mm	3000	N/A	very quiet	Filtered and aided by thermal pads; effective
Just Cooler HD-600	1 x 54mm, ball bearing	3500	18	very quiet	Compact; cools PCB
Vantec HCP5252	2 x 60mm, ball bearing	3800	28	quiet	3.5-inch version available
Vantec VTX-COI-BK Vortex	1 cylindrical, ball bearing	2000-3700	16 to 30	so-so whiny to thrumming, throbbing	Fan motor wouldn't stay aligned; temp probe and readout
Zalman ZM-2HC2 Heatpipe	n/a (11 heatpipes)	N/A	N/A	silent	A little weighty; rubber dampers quell vibrations

Heatpipe Power

We Review The Latest & Greatest In CPU Heatsinks

Heatpipe CPU coolers are smokin' hot. A few years ago, heatpipe technology was virtually unheard of, but these days you can't visit an online PC shop without seeing scads of heatpipe-based products designed for CPU and GPU cooling.

None of these heatpipe products are the same. They come with almost completely different configurations and designs, and they vary widely in price—though you can pretty much count on the fact that every one of them will be significantly more expensive than a traditional aluminum heatsink.

Even products that look similar on the surface have very different traits. Some manufacturers put a lot of extra effort into their products by providing high-quality components and installation hardware and bundle their heatpipe coolers with excellent instructions. Other companies don't provide nearly as much value with their coolers, leaning on heatpipe marketing hype to move their products. As with every technology that has visual appeal—and heatpipe coolers are definitely eye-catching—some products have more style than substance.

We set out to find which heatpipe CPU coolers are best suited for cooling a hot-running Pentium 4 processor. After the final tests were completed, we had a much better idea of which coolers provide superior cooling and those that were more likely to leave your CPU sucking a lot of hot air.

How We Tested

We selected only heatpipe coolers equipped to sit on a Socket 478 Pentium 4 CPU. That's not to say that these coolers work only with Socket 478 because most of them work with other socket

types. We've listed socket compatibility in each product's review.

Our base system remained the same for each cooler we tested. We used an ASUS P4C800-E Deluxe motherboard paired with a Pentium 4 3.06GHz CPU, 1GB OCZ EL Dual Channel Series Gold Edition DDR4400 RAM, and a Gainward NVIDIA GeForce FX5900XT video card. We installed our setup in an Antec super-mini tower case equipped with a 300W power supply.

We used two tools to gauge each heatsink's effectiveness. We ran Motherboard Monitor to track the CPU's internal temperature, and we placed temperature probes on each heatsink, too. Although software temperature readings have a reputation for inaccuracy, combining those results with the harder numbers we detected via probes gave us a clearer picture of a heatsink's value.

In addition to the quantitative evaluation of each cooler's performance, we also made a number of qualitative observations regarding other physical characteristics of the heatsinks, such as overall design, aesthetics, and workmanship. We also judged the products by the quality of their instructions and packaging.

We considered products that succeeded on all counts to be outstanding. But regardless of our final impression, we pointed out shortcomings we noticed with the products and think you'll find these notes useful as you ponder ways to obliterate your cooling budget.

AeroCool High Tower Jr.

\$40 • www.aerocool.us



It's fitting that we begin our reviews with an AeroCool product, because this company was one of the first to integrate heatpipe technology into CPU cooling products.

The Jr. part of this product's moniker has nothing to do with size. Instead, it simply differentiates this heatsink as an aluminum version. The copper design sells with the original High Tower name. That product is heavier and it also has a heftier price, selling for a whopping \$20 more than the High Tower Jr., which goes by the name HT-101jr on AeroCool's Web site.

The High Tower Jr. comes with three "superconductor tubes," otherwise known as heatpipes, which are connected to a long row of aluminum fins. AeroCool packages this heatsink with a single 80mm fan that spins at 2,500rpm and has a noise rating of 24.6dB (decibels).

This heatsink has a couple of characteristics that will seize the attention of detail-oriented modders. For one, the Jr. stands nearly five full-inches tall. And two, the open-faced design of the fins lets you install not one, but two 80mm fans: one to either side of the heatsink.

This product included a one-page color foldout of photo-laden instructions. It was obvious from the get-go that of all the heatsinks we tested, this one was the least P4-friendly. Before we could even begin the installation, we had



The High Tower Jr. from AeroCool is an aluminum-based heatsink that's much more affordable than its copper-based relative.

to dismantle part of the preinstalled bracket. That was the easy part.

After installing the P4-compatible base, we had to perform a circus high-wire juggling act to secure the heatsink to our CPU. We held the base plate to the back side of the mobo, slid four plastic standoffs over each screw hole, placed the heatsink over the standoffs, and tried to hold everything steady while we inserted four screws.

This process was as hard as it sounds, and really, it was much harder because the full-color instruction sheet was a bust. The skimpy, imprecise text refers to confusingly named parts of the heatsink, terms that left us mentally composing vulgar email messages to AeroCool's engineering department. After nearly an hour of struggling, we finally had the heatsink and motherboard in place.

We're not sure the High Tower Jr. was worth all that effort. It registered some of the highest temperatures in our roundup and it was one of only two heatsinks that resulted in an idle CPU temperature above 30 degrees Celsius.

The High Tower Jr. didn't impress us the way its older, copper brother did; we think you can do better for the approximately \$40 price tag. This AeroCool heatsink is also compatible with Athlon 64 and Athlon XP mobos.

Arctic Cooling Freezer 4

\$40 • www.arctic-cooling.com



The Freezer 4 has an odd-looking, but effective, design.

Like the High Tower Jr., Arctic Cooling's Freezer 4 is a budget-conscious

heatpipe-laced heatsink that's designed to offer maximum cooling at a cost that's nearly half the price of top-shelf products.

This heatsink uses aluminum as its base material. However, the four imbedded heatpipes are made from copper and they're soldered to a copper base that rests directly on your CPU. At worst, the Freezer 4's overall look is a bit underwhelming; at best, it looks like a tidy piece of minimalist art. Its simple, square aluminum fins stand firmly on the four heatpipe legs, and there's a single 80mm fan spinning at 2,200rpm to dissipate heat.

On the downside, we've had one too many fingers snipped by high-RPM fans, so we aren't aficionados of grille-less fan systems. The completely unprotected blades on the Freezer 4 will threaten both man and, perhaps more importantly, PC component wiring. And even sans grille, this is a heatsink of substantial size, measuring almost five inches on each side, with a weight of 488 grams.

Arctic Cooling offers a few skimpy installation instructions on the side of the box, but the company's illustrated tips on its Web site are much more helpful. We didn't have any real problems installing the Arctic Cooling Freezer 4. It was one of the few products we tested that utilized our P4's stock heatsink bracket, a trait that you'll appreciate if you hate removing your motherboard before you can fasten a new cooler to your CPU. However, the sheer height and bulk of the product made it somewhat difficult to maneuver our hands as we secured the clips to the bracket.

What's more, we had a very difficult time trying to loosen the grip of this heatsink when we were ready to uninstall it from our case. Both of the spring clip fasteners are located on the same side of the heatsink, meaning you have less flexibility when orienting the product to match your socket's idiosyncrasies.

In spite of its funky design, the Freezer 4 does offer substantial cooling power. It finished in the middle of the pack in terms of cooling ability, with a CPU working temperature of 44 degrees C.

This Arctic Cooling heatsink is a good value after you consider its price and performance. The Freezer 4 we reviewed was

a Socket-478-only product, although it is also available for Athlon 64 and Socket 775 systems.

Cooler Master Hyper 48

\$50 • www.coolermaster.com



Its huge copper base and efficient fan made the Hyper 48 one of our roundup's standout performers.

One of the first words that come to mind when you see Cooler Master's gargantuan Hyper 48 is "frightening." From your first glimpse, you understand that this heatsink isn't messing around, and your motherboard will know it, too, because including the top-mounted 92mm fan, the all-copper Hyper 48 is a beefy 864g, enough to subject your mobo to considerable strain.

If that doesn't sound like much weight to you, consider this: Some heatsinks that weigh about 100g heavier than the Hyper 48 have been known to break motherboards. And that doesn't take into account the potential hairline cracks and miniscule fractures in circuitry that could possibly affect system performance. However, the Hyper 48's weight has a lower center of gravity than other products we tested. Even with the fan adding to its height, the Hyper 48 is only around four inches tall.

The weight of this heatsink necessitates the use of a back plate for the underside of your mobo, meaning you'll have to pull your system apart for the installation. Cooler Master includes a single sheet of illustrated, fairly clear step-by-step instructions to assist this process.

Installation was quick and easy. We used the described seven basic steps to

dismantle our mobo's integrated CPU socket bracket and then attached the universal back plate to the reverse side of the board, securing the plate and the board's original bracket with the included screws. We pressed two simple spring clips onto the copper midsection of the heatsink to make sure it remained stationary.

Because the spring clips weren't integrated into the bracket itself, we had the option of orienting the clips to best

match our mobo's component layout. This is a nice, and oft-overlooked, setup that makes installation and removal much easier for users who have mobos loaded with capacitors that crowd real estate around the socket.

Our tests showed that the Hyper 48 works very well—it recorded one of the lowest CPU working temperatures. What's more, the heatsink itself stayed cool, too, thanks to the effective fan performance.

How Heatpipes Work

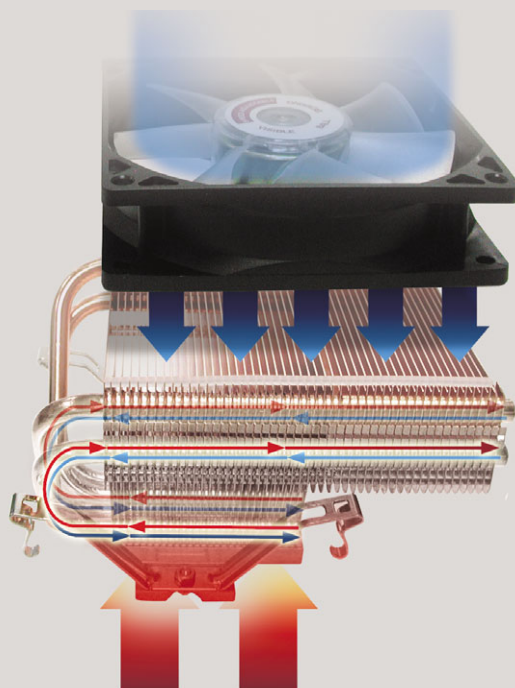
Heatpipes are vacuumed pipes containing a liquid that converts into vapor at the point of contact with a hot object. The vapor rushes to the other (cooler) end of the heatpipe where it releases excess heat and reverts to a liquid state. Then the liquid drains back towards the other end of the heatpipe, where this entire process recurs continuously until you shut down your computer and your CPU cools to room temperature.

Heatpipes may contain fancy liquids (called the working fluid) such as ammonia or ethanol, but heatpipes created for CPUs generally use just plain, pure water as the working fluid. You might wonder how your CPU boils water into vapor before it vaporizes its own transistors, but if you remember your basic science lessons, you know that water boils at a much lower temperature when it's in a vacuum. That trait makes water a useful working fluid at temperatures ranging from about 30 to 200 degrees Celsius.

To assist the movement of the working fluid, each heatpipe has an internal wicking material that generally consists of tiny, braided metal wires. When the vapor condenses back into liquid form at the cooler end of the heatpipe, these braided wires help the liquid flow back to the hotter areas of the heatpipe.

It's worth noting that some heatpipe coolers are less efficient when mounted upside down. This is true because many such products are designed to work in an angled or upright position, and when they're upside down, the liquid doesn't circulate as effectively, a problem that the wicking material helps combat.

Heatpipes have effective thermal conductivity that's exponentially greater than that of regular copper, a fact that makes them better suited for hot CPUs than a traditional fan/heatsink cooling combo. However, heatpipe coolers are usually significantly more expensive than a regular heatsink and heatpipe coolers are bulky, too. But for serious users, the trade-off is often worthwhile. ▲

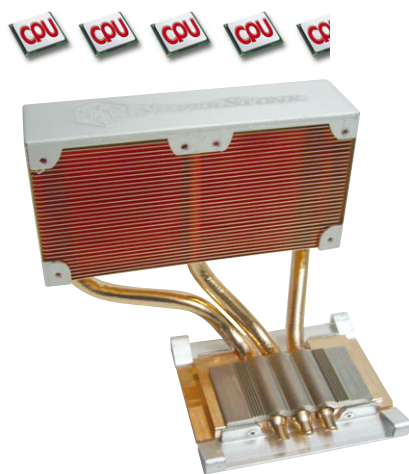


The Hyper 48 comes with mounting hardware for 754, 940, 939, and 775 socket types.

There's no doubt that the Hyper 48 provides cooling far superior to an ordinary Intel heatsink or that this copper behemoth will adequately absorb excess heat from overclocking. The only questions are: Do you want your heatsink to be a showcase piece of your system—and do you want to make your motherboard scream? If the answers are yes, the Hyper 48 is for you.

SilverStone Nitrogon NT01 (version 1.0)

\$60 • www.silverstonetek.com



An innovative design means you can use the Nitrogon NT01 in a case that conforms to the tiny Micro-ATX form factor.

Most heatpipes use a sort of braided wire as the internal wicking material. The heatpipes integrated into the SilverStone Nitrogon, however, use a more expensive sintered-powder wick that has several channels for unimpeded vapor travel, as well as numerous larger spaces for faster liquid flow. These improvements allow for tighter bends in the heatpipes and offer improved cooling capabilities when the heatsink is mounted in an orientation (see: upside down) where gravity restricts the working fluid's flow.

This product's overall appearance is also very different from others we tested. The heatsink fins don't sit directly on the heatpipes; instead, the three large pipes zoom out from the plate at a 90-degree angle and disperse their heat through fins

that accommodate two 60mm fans, which aren't included in the box.

The unique design means that this heatsink will work with components built around the Micro ATX form factor, as well as the traditional ATX form factor. However, that design doesn't necessarily equal space efficiency. The fanless setup weighs in at nearly 590g, and the sprawling aluminum frame spans five inches wide and more than four inches tall.

The Nitrogon comes with a booklet containing illustrated installation instructions and an interesting array of numbers that will give you an idea of what kind of cooling performance you can expect. We consulted the information sheet as we began affixing the heatsink to the top of our CPU, but because the process was so simple, this move was entirely unnecessary.

To install the Nitrogon, we merely removed our stock Intel heatsink, slid our new heatsink into place, and used SilverStone's springy retention clips to finish the job. Unlike some of the other largish heatsinks we reviewed, the Nitrogon has an airy base that makes it easy to maneuver your fingers around the heatpipes and fins, a fact that contributed to the effortless installation.

We screwed two 60mm fans onto the heatsink to help push hot air away from our CPU. The obvious downside to this setup is that 60mm fans tend to make more noise than their 80mm and 120mm counterparts, and the fact that you need more than one for the Nitrogon won't help when you want to keep your system quiet.

In our tests, the Nitrogon tied with the Thermalright XP-90C heatsink for the lowest working CPU temperatures. Those scores alone convince us that the Nitrogon is an excellent cooler.

The Nitrogon's unusual design and compatibility with multiple form factors contribute to its expensiveness—after all, there aren't many fanless heatsinks that sell for nearly \$60 to \$70. If you have an extremely crowded ATX case, you might find some usefulness in a heatsink that shifts much of its space consumption to the rear of the case. But the real power of the

Nitrogon will be most convenient to those of you building overclocked mini PCs. Just keep in mind that the Nitrogon is for Socket 478 systems only. If you use a different socket, you can look into v2.0 of this heatsink, which works with LGA775 and AMD sockets 754, 939, and 940.

Thermalright XP-90C

\$50 • www.thermalright.com



Thermalright's XP-90C is efficient and affordable, but it doesn't come with a fan.

Cooling extremists love copper, and Thermalright knows it—thus, we have the XP-90C, one seriously colossal chunk of this shiny, penny-colored element. This heatsink has almost 700g of copper packed into its

frame, which is 4.5 x 3.8 x 3 inches (HxWxD).

As with most Thermalright heatsinks, this one comes in a brown box that's deceptively plain. Inside, you'll find the XP-90C and its installation hardware neatly packaged and well-protected by plastic wrap. You also get a foldout sheet with excellent illustrations and complete text instructions to guide installation. You won't find a fan, however. That means you'll have to provide a 92mm fan of your choice, which will add to this product's already significant price.

If you don't fear for your mobo's circuitry when you begin installing the XP-90C, you've subjected your synapses to too many caffeine binges. This heatsink is heavy and its unusual design means that it doesn't carry its weight with much grace. Still, this heatsink is tough. Unlike some oversized heatsinks, the XP-90C isn't a bloated, flimsy caricature of smaller and more effective cooling products. Rather, the XP-90C has super-tough fins that don't flex at all, even when you apply significant force to them.

We had little trouble installing this ThermalRight product, but depending on your circumstances, you might not be so lucky. If you have a mobo with a CPU socket that's hemmed in closely by

Put This In Your Pipe & Smoke It

Heatsink testing is no simple feat. There are too many variables (CPU heat production foibles, uneven dissipation of heat through a heatsink, software inaccuracies, etc.) that can account for wild changes in temperature readings and resulting conclusions. But there are ways to minimize problems in a quantitative analysis of heatpipe performance; in our case, we used both hardware and software to assist our project. We used Motherboard Monitor and a control panel equipped with several temperature probes to track heat dissipation activity. And instead of simply proffering idling-speed temperatures, we put our CPU (and thus, the heatpipes) to work with CPUBurn, a program that gave our CPU a hard workout. ▲

Product	Surface temp (idle)	Motherboard Monitor CPU temp (idle)	Surface temp (working)	Motherboard Monitor CPU temp (working)	Noise level (decibels)
Stock Intel heatsink	29	27	42	47	62
AeroCool High Tower Jr.	29	31	36	61	63
Arctic Cooling Freezer 4	28	27	33	44	55
Cooler Master Hyper 48	28	26	38	43	48
SilverStone Nitrogon NT01 (version 1.0)	29	27	34	36	72
Thermalright XP-90C	25	26	35	36	63
Thermaltake SonicTower	26	28	33	57	60
Thermaltake SonicTower (without fan)	41	43	64	76	0

CPU Ranking: 0 = Absolutely Worthless 2.5 = Absolutely Average 5 = Absolutely Perfect

capacitors, chipset heatsinks, or other components, you might struggle to orient this heatsink in a way that makes you happy and you might have a hard time fastening the clips to the socket bracket.

We started by removing our motherboard and installing the back plate on the mobo's underside, and with four screws, we secured a black metal bracket around the CPU socket. The next installation step required us to secure the XP-90C to the socket using spring-loaded clips integrated into the heatsink's body. This step took some extra care, due to the XP-90C's protruding heatpipes and large girth.

We managed to settle the XP-90C onto our socket without too much trouble. With that task complete, we placed vibration-absorbing rubber strips atop the fins and then used the included wire brackets to secure a 92mm fan to the XP-90C's peak. The fan brackets look impossibly flimsy, but they actually create a very firm connection.

With the XP-90C in place, we performed our slate of experiments and immediately knew we had a winner. This heatsink matched the Nitrogon's cooling effectiveness blow for blow, making it hands down one of the best products in this roundup.

Thermalright has an excellent reputation for good reason—it makes stupendous heatsinks, and the XP-90C is no exception. If you want a serious heatsink for serious cooling work, this copper beast won't disappoint. And if you're using a different CPU, this product also fits Socket 754, 939, and 940 configurations.

Thermalright SonicTower

\$50 • www.thermalright.com



Passive CPU cooler or race car radiator? The SonicTower from Thermalright was by far the strangest-looking heatsink we tested.

Modding products offer computer geeks a chance to show off their interior decorating prowess. Thermalright's SonicTower is the kind of PC visual artistry you select when you want people to mistake your motherboard for a go-kart motor.

At 6 inches tall, 4.5 inches wide on four sides, with a weight of 692g, the SonicTower is one of the biggest heatsinks you'll find. It's also one of the few heatsinks designed for high-power CPUs, and what's more, the SonicTower is supposed to work passively—that is, with no fans attached to provide forced-air cooling. However, for more effective heat dissipation you can secure a 120mm fan to the heatsink by using the supplied brackets.

This Thermalright product has a copper base sprouting three heatpipes that curl up into six aluminum towers with 110 fins each. Overall, the look will grab your attention, and there's no doubt that the silvery, fanless surface will look groovy in PCs with artsy lighting schemes.

The heatsink comes neatly packaged in tough plastic, with a box containing a bag that holds the necessary installation hardware. You also receive a one-page color foldout with clear and concise installation instructions, which is a good thing, because you also get five bags filled with screws and other assorted hardware.

A number of descriptors came to mind while we were attempting in vain to install the P4 bracket for this heatsink: asinine, ill-conceived, worthless, exasperating. We thought of other, more colorful adjectives, but those are unprintable in a family-oriented publication. Suffice it to say that this installation process requires four miniature hands sprouting from the body of a dexterous and super-intelligent spider monkey.

And even when magic monkey man manages to install the SonicTower according to directions, he'll be stuck with this unnerving reality: the P4 bracket sucks. The fit is shaky and insecure, and we'd never leave this heatsink mounted above a \$250 video card, much less trust

it cooling a CPU. But because the CPU and video card in these tests belonged to the publishing company and not to us, we had no qualms about facing their potential destruction. We gingerly installed the SonicTower and prepared to perform our slate of tests.

Before we did so, however, we wanted to install a 120mm fan to give the product extra cooling power. Much to our dismay, the fan installation instructions included at the bottom of our foldout revealed another frustrating reality—in order to fasten fan brackets to the SonicTower, the product needs to be uninstalled from the motherboard. We sighed.

The results we saw from these tests were less than impressive. Without a fan, our working CPU temperatures shot to nearly 80 degrees. But the tests we ran with a fan were even more telling—the working CPU temperature still pushed 60 degrees C.

We're normally impressed with Thermalright products, but the SonicTower we tested looked more impressive than it really was. If you really want quiet cooling, look elsewhere or consider a hushed watercooling setup. In addition to Socket 478, the SonicTower works with Socket 775, Athlon 64, and Athlon XP CPUs.

The Cool Down

Don't expect the rampage for heatpipe CPU coolers to end anytime soon. Manufacturers continually tweak their designs to improve heat dissipation properties and to keep up with ever-increasing CPU heat output, too.

To the delight of modding enthusiasts everywhere, heatpipe heatsink manufacturers are also very conscious of their products' visual appeal. Expect increasingly funky designs to appear, but remember that a snazzy-looking heatsink might wow your friends, yet offer very little value when you consider the price-to-performance ratio. But if you do a little preshopping research and invest your cash wisely, you'll wind up with a cutting-edge heatsink that's capable of pushing your cooling system to unprecedented levels of effectiveness. **CPU**

by Nathan Chandler



coming soon . . .



Danger Den Wood Case



A waterblock that cools both the Nvida 6800/7800 GPU and RAM



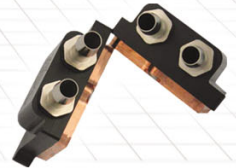
NEW
Danger Den Hard Drive block,



Danger Den Power Kit



Danger Den Fillport to easily add water to the system



Danger Den MAZE4GPU that cools both ATI and Nvidia graphics cards

DANGER DEN

www.dangerden.com

Ice Your Baby

Cooling Products To Relieve Your CPU's Burns

Heat is one of the most destructive elements your electronics face, and as PC components become faster, they generally produce more heat, too. It's a double-edged sword of performance and self-destruction, one that you alone are responsible for wielding properly. Underestimate your PC's cooling needs, and you'll feel the pain when you have to spring for a replacement CPU, motherboard, or other pricey, burned-up component.

We tested CPU watercooling kits, heatsinks, and hard drive coolers to give you an idea of what's available and also to let you know what kind of performance you can expect from these devices. You'll see that some products offer excellent cooling clout, while others do little to cool your PC's fire.

How We Tested

Our review procedures differed slightly for each product category. But without exception, we judged our gear on component quality, the helpfulness of included documentation, and overall cooling performance.

We connected each product to a 3.06GHz Pentium 4 nestled onto an ASUS P4C800-E Deluxe motherboard. Our test system also included 1GB of OCZ EL Dual Channel Series Gold Edition DDR4400 RAM, and a Gainward NVIDIA GeForce FX5900XT video card.

After we installed each cooling device, we let Windows XP Professional idle for 30 minutes. Then we recorded CPU temperatures using Motherboard Monitor and temperature probes connected to a MacPower DigitalDoc. To

up the ante, we used CPUBurn to increase the CPU's heat levels for 30 minutes, after which we recorded the new temperatures. We considered these quantitative results and combined them with our subjective evaluations to decide whether we'd use the product in our own systems. We used slightly different procedures for hard drive coolers, which we monitored only with the DigitalDoc.

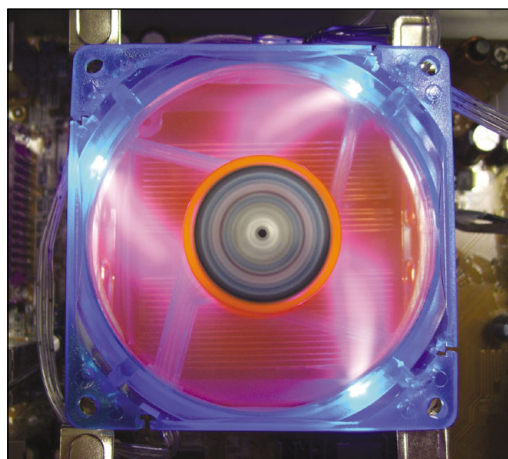
Although we realize that temperatures from programs such as Motherboard Monitor are often wildly inaccurate, we balanced those numbers with temperature probe results to offer you a good idea of how well each product worked.

CPU Heatsinks

There is a dazzling array of heatsinks available for every socket type. Here, we tested a number of popular heatsinks and found that some coolers work much better than others.

AeroCool Extreme

\$35 • www.aerocool.us



The AeroCool Extreme, by contemporary standards, doesn't appear to be very extreme. On the surface it appears to be a rather average-looking copper heatsink adorned with a blue fan. In regard to our tests, however, the Extreme moniker took on a different meaning (Extremely Exasperating) that AeroCool marketers won't appreciate.

From the spec sheet and photographs of the Extreme, you'd definitely think this heatsink is worth a look. It's equipped with a base and fins made from copper and a quiet fan with pretty blue lights, and it works with AMD and Intel socket configurations. Best of all, in spite of its all-copper construction, the Extreme is compact and light, at only 2.7 inches high and 330g—a size and weight that's more merciful on your motherboard than many other copper heatsinks.

Socket A users will appreciate how easy it is to install the Extreme. Because the product comes with integrated Socket A clips, all you have to do is clip it on and go. If you buy the Extreme for a Socket 478 mobo, however, be prepared for some serious gnashing of teeth.

For a P4 installation, you have to disassemble this product by removing the fan and Socket A bracket. Then you screw two retention clips between the fan and heatsink and then clamp the clips down onto your stock Intel socket bracket. In theory this sounds easy enough, but we found that it was difficult to center the heatsink over the CPU using the P4 brackets, and the heatsink tended to wiggle more than we liked.

Our initial test results were not good. Motherboard Monitor reported a CPU temperature of 40 degrees Celsius, far too high for an idling processor. Upon closer inspection, we found that one of the retention clips wasn't keeping the heatsink firmly clamped to the CPU. To correct this problem, we had to adjust the clip's tension by moving its prongs to a lower slit on the clip's legs, a process akin to tightening your belt another notch after you've been on a caffeine-only diet for a week.

With that adjustment, the Extreme's performance improved drastically, with

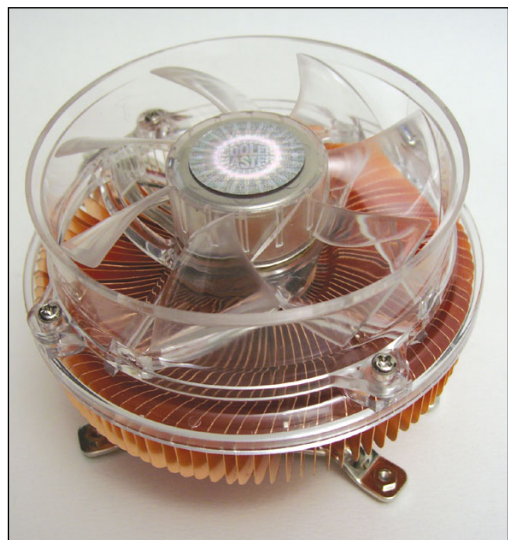
CPU Ranking: 0 = Absolutely Worthless 2.5 = Absolutely Average 5 = Absolutely Perfect

an idle temperature of 27 degrees. The working temperature, at 47 degrees, was higher than we've seen from other similarly priced heatsinks.

Because of the installation problems we experienced, we wouldn't recommend the AeroCool Extreme for P4 PCs, especially considering the substantial price. However, if you're an AMD user and you find this product on sale, the Extreme should serve you well.

Cooler Master Ultra Vortex

\$35 • www.coolermaster.com



The Cooler Master Ultra Vortex is an all-copper heatsink, which means, of course, that in addition to providing excellent cooling, it also weighs a lot. You can't ignore the extra heft of the Ultra Vortex. With the large fan on top, it's nearly 800g, which will definitely put some strain on your motherboard. Fortunately, Cooler Master managed to keep the form factor rather squat, so with the fan in place, this heatsink is only about 4 inches high, significantly shorter than other heavy heatsinks.

The Ultra Vortex offers, literally, a couple of new twists on CPU cooler technology. The copper fins are actually curved, a design that's supposed to improve airflow. We noticed immediately after we opened this product that the fins weren't evenly spaced and that they were rather flimsy

when we touched them, a fact that will perturb picky buyers. In addition, the 92mm fan atop this heatsink is round instead of rectangular, which improves this product's feng shui potential but won't offer any performance boosts. This fan comes with an RPM knob that you can install in an open expansion slot, and its spin rate ranges from 1,400 to 3,000rpm.

Cooler Master included a one-page sheet of multilingual instructions, complete with tiny photographs to assist our installation. We didn't encounter any insurmountable problems during the installation process; however, we did have to uninstall our motherboard and hold the heatsink to the top of the CPU while we secured screws from the back side of the mobo.

We ran into bigger problems, though. A fan connector on our motherboard interfered with one of the heatsink's steel legs, and the only way to complete the installation was to bend the connector's plastic shielding 2mm away from its base. Keep this in mind if you have a motherboard with connectors or capacitors in close proximity to the CPU socket.

Then we lifted our motherboard and felt for ourselves what kind of burden this heatsink will place on your printed circuit board. You should rarely move your PC when you have this monstrous heatsink in place, and then only very carefully.

If you're willing to deal with the Ultra Vortex's massiveness, you'll likely be pleased with the results. The heatsink performed very well in our tests, keeping our hot P4 about 6 degrees cooler than the stock Intel heatsink. We liked the adjustable fan, which is fairly quiet at full speed and nearly silent when at its slowest setting.

We were a bit skeptical about the Ultra Vortex because of its tremendous weight and the installation problems we encountered. However, there's no arguing with this product's cooling ability. If you're looking for an all-copper cooler with a large adjustable fan, this one will keep your CPU cool, quietly.

Spire Coolwave

\$25 • www.spirecoolers.com



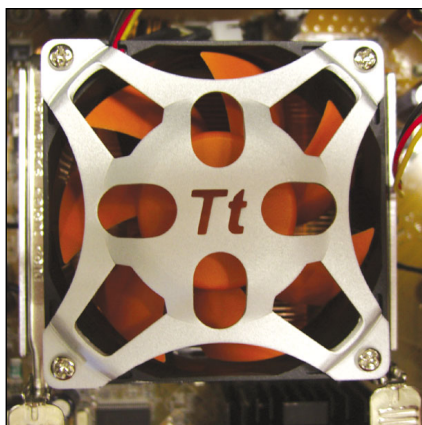
Most high-tech CPU coolers cost upwards of \$30, but Spire has made a name for itself by providing high-quality heatsinks at budget prices. The same is true of this company's Coolwave cooler, an all-copper heatsink that costs only around \$25.

That's a remarkable price for a heatsink made of copper, but the low cost is even more noteworthy when you realize that the 70mm fan comes with a speed control knob that you can mount in an empty expansion card slot. Using this knob you can choose a fan speed anywhere between 2,000 and 4,200rpm.

The Coolwave's size sets it apart, too. You can choose from many crushingly heavy copper heatsinks that consume a lot of precious case space, but in comparison this Spire product is lightweight and measures only around 2 inches after installation.

With the fan speed set to the middle of its range, idle temperatures hovered below 30 degrees C. Working temperatures moved upward to around 50 degrees. We cranked up the fan speed to maximum during our CPU Burn test, and the highest temperature we recorded was 49 degrees.

At lower speeds, fan noises were nearly unnoticeable. But the 70mm whine became unmistakable as we increased the rpms. If you want a very quiet and very cool machine, this is not the heatsink for you. However, if you don't overclock a lot and you won't need the fan to run at full speed all the time, the Coolwave is a super-solid product for the price.



Thermaltake Spark 7+

\$35 • www.thermaltake.com



Thermaltake's Spark 7+ is distinctive for a number of reasons, not least of which is its long-lived popularity—retailers have been selling this product for almost three years in a market that seemingly sees heatsinks come and go with every sunrise. But after you consider the Spark's spec sheet, it's no surprise that this product has legs.

This heatsink was ahead of its time at its introduction, sporting around 50 copper fins welded to an all-copper base. On top, you'll find a 70mm fan protected by a cool fan grill embellished with the Thermaltake logo. That fan has three sets of wires sprouting from its body.

Those wires let you set up the fan to adjust its rpm level to keep heat levels down automatically. You can also connect one of two speed knobs that will let you set spin rates manually. That's no misprint—you actually do get two different fan controllers that you can install, one for a 5.25-inch drive bay, and one for an empty case expansion slot. These control knobs let you adjust fan speed from 1,300 to 6,000rpm with just a twist of your fingers.

Installing the Spark to a stock Intel heatsink bracket was a snap, literally. We simply used the sturdy steel heatsink clips to secure this product to the motherboard. This process took only a few minutes, and we didn't need the full-color instruction sheet.



Cooler Master Aquagate

\$205 • www.coolermaster.com



Cooler Master's Aquagate is an unusual take on the water-cooling kit genre. It comprises a stylish metal box containing a reservoir, fan and radiator, and an LCD control panel. You'll have a centralized box with all of your cooling components, rather than facing a case with parts strewn all over the place.

This is seriously heavy-duty cooling hardware. The Aquagate comes with a thick, heavy copper waterblock that has a see-through acrylic top. It also has very rigid tubing, though in the 1/2-inch variety that many modders prefer.

If you want to install the Aquagate inside your case, you'll need an extra PSU mount, or two spare 5.25-inch drive bays. We opted for the external installation in order to keep heat from the unit outside the case where it belonged.

By nature watercooling kits are often complicated to assemble. You have a lot of tiny parts that need to fit together precisely, otherwise you'll run into problems, like the ones we experienced with the Aquagate. This product came with many wires, screws, springs, and brackets that required attention to detail. Unfortunately, in spite of the thick manual, the illustrated instructions were skimpy on details, leaving us to perform some trial and error procedures during the installation. This process was slow and took us nearly an hour to complete.

Then we filled the water reservoir and began bleeding air bubbles out of the hoses and waterblock. Cooler Master was nice enough to simplify this process by including a fill hole in the water reservoir. Unfortunately, if you don't completely screw down the cap on the reservoir between fill-up sessions, the coolant fairly bursts out of confinement. We learned the hard way to keep this cap on tight at all times.

Our next problem was again due partially to user error. When we installed the

The advantage of a small heatsink is compactness in a case loaded with other components. The Spark 7+'s downside is that it uses a 70mm fan, which makes more noise and moves less air than larger fans. With the fan set to its lowest level and our system at idle, the CPU temperature was a warm 32 degrees C. Then we put our CPU to work, and its temperature shot to 62 degrees in just a few minutes. Revving the fan to its medium setting lowered temperatures to 47 degrees, and with the fan at maximum speed, the CPU temperature topped out at 44 degrees.

Don't plan to use this fan at full speed, though, unless you don't mind a raucous fury coming from your computer case. This fan has exactly the loud whine you'd expect from a small fan spinning at very fast speeds. However, at midrange or low speeds, the fan's sounds are quite tolerable.

For very hot CPUs, you'll have to use the higher fan speed settings, which is why we'd hesitate to recommend this cooler if you're using a P4 that's faster than 2.8GHz. However, for slower P4s this product provides a lot of capabilities and cooling performance for a very reasonable price.

Watercooling Kits

Watercooling equipment is standard gear for overclockers and modders, and kits make watercooling easier than ever before. But we found that some kits provide much more value for your money than others.

CPU Ranking: 0 = Absolutely Worthless 2.5 = Absolutely Average 5 = Absolutely Perfect

included temperature probe on the waterblock, we damaged it, causing the Aquagate to go haywire during startup—and subsequently it shut down the computer to avoid potential heat damage. After we pinpointed the probe as the source of the problem, the Aquagate worked fine.

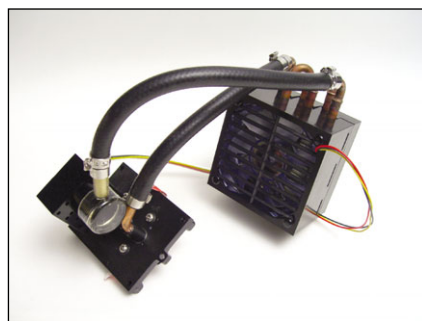
When we were done, we were left with a pump, reservoir, and radiator assembly sitting outside our case. This stylish box of components was fronted by an LCD panel that let us control fan speed, monitor temperatures, and set temperature threshold alarms.

The system as a whole was very quiet when the radiator fan was set to low speed. However, at its second and third setting, the fan made a lot more noise, to the point that you'll be aggravated to no end if you're sensitive to whiny fans. As it turned out, the middle fan speed setting was very effective in cooling a burning-hot CPU, one reason this system will be suitable for beginning and hardcore overclocking enthusiasts.

Still, this is a pricey purchase, and one that condescending DIY overclocking enthusiasts will likely sneer at. But if you want a fairly compact and user-friendly cooling system, you'll appreciate the Aquagate.

G-Cooler Pentium 4 CPU Liquid Cooler

\$60 • URL N/A



Watercooling kits are traditionally rather expensive for a couple reasons. One, they bring together many disparate parts into a system that provides excellent cooling for overclocked CPUs. And two, water and electronics don't mix, so you

need high-quality parts to ensure the survival of your pricey PC.

The G-Cooler watercooling system we tried shattered both of these maxims. This kit comes preassembled, and has a measly price tag of only about \$60. From the price alone, you know that some serious corners were cut in the development of this product, but the G-Cooler surprised us in a number of ways.

When we opened the box, we had a feeling that the installation process wasn't going to take much work. The entire system—radiator, fan, water hoses, and waterblock—were tightly cinched together with metal hose clamps on tough black hoses. Using a few bits of included hardware and the laughably mistranslated instruction sheet, we installed the system in about 10 minutes.

We weren't overly pleased with the system's appearance, as the fins on the radiator were bent and twisted in spite of the thick padding used to ship the product. And the so-called waterblock, a rectangle of plastic with a thin piece of imbedded copper, was rather goofy-looking compared to the rock-solid waterblocks we see in high-end kits. In the end, though, the overall construction quality of this setup seemed adequate considering the price.

With our system at idle, we saw CPU temperatures that were nearly the same at the ambient air temperature inside the case. As anticipated, things became quite a bit warmer once we kicked CPU Burn into gear. We saw a maximum CPU temperature of 44 degrees, and the metal tubes on the system became warm to the touch during these workout sessions. Because the fan wasn't adjustable, we were stuck listening to a substantially noisy set of blades for the duration of our tests.

Don't kid yourself. If you really need high-quality watercooling to keep your expensive CPU from burning itself into cinders, this isn't the system for you. The waterblock is wimpy, and there's not enough water inside the system to provide much cooling power; in fact, you might be better off investing in a copper heat-pipe heatsink in the same price range. But if you perform moderate overclocking a

few times per week and simply want a bit of water to douse your CPU's fire, this basic product will do the trick.

Innovatek Premium XXS

\$220 • www.innovatek.de



Innovatek's Premium XXS watercooling kit came loaded with well-built parts and tasty bits of gummy candy bearing the company insignia. Sadly, instructions were in short supply.

We sifted through our box of packaging materials and dredged up only a couple of paragraphs, with one illustration, explaining the Socket 478 installation. Fortunately, it was easy to figure out—all we had to do was fit a plastic retaining clip over the waterblock and snap the clip into the stock Intel socket bracket. It was an elegant setup and very secure.

As we installed this system, we noticed the excellent build quality of each component. Whereas some kits are merely a jumble of average- or low-quality parts, Innovatek included metal and high-impact plastic materials, tough 1/2-inch hoses, and metal hose connectors. And unlike so many kits that pawn off regular aquarium pumps as PC components, this pump is retrofitted with a Molex connector that's compatible with PSU plugs.

We did experience some frustration during the installation. The large 120mm was hard enough to squeeze into the case, but the reservoir, which didn't look at all big until we attempted to mount it, would fit only on the outside of our mid-tower case. Unless you have a lot of open space in your box, you should expect to encounter a similar scenario.

We were happy with the Innovatek system's cooling power. With our PC doing nothing displaying the Windows desktop, the CPU temperature was a chilly 25 degrees C. When we over-loaded the CPU for more than 30 minutes, its hottest point was a mere 36 degrees, much cooler than with a forced-air system.

Effective cooling didn't equal a mess of noise from our PC case. The 120mm fan was quiet enough that it shouldn't bother you unless your PC sits on your desk. Better yet, the water pump put out a barely discernible hum, nothing like the angry buzzes that often rattle cheaper pumps.

This kit is very expensive, and it's difficult for us to recommend it considering the fact that you could buy excellent parts separately and save a lot of money. But it's not hard to see why Innovatek has such a good reputation among the water-cooling crowd. This kit's attention to detail (minus the lackadaisical instructions), ease of use, and effectiveness make it an excellent tool for overclocking.

Swiftech H20-120-F (Revision 3a) Watercooling Kit

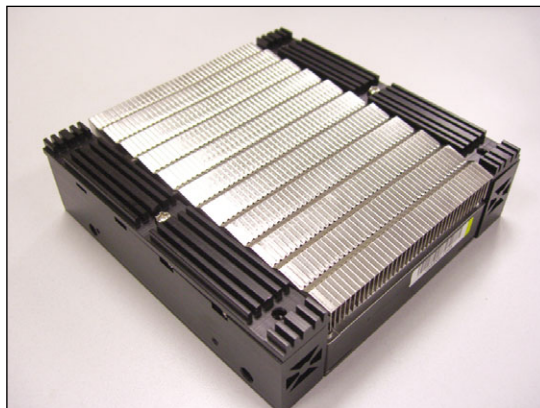
\$220 • www.swiftnets.com



The MCW6000 waterblock included in this Swiftech kit is simultaneously plain and breathtaking. It's nothing more than a polished hunk of copper with two hose barbs, but the block is also exceedingly heavy, a dead giveaway to this block's excellent cooling potential. Swiftech also threw in a 120mm radiator equipped not with cheap, flimsy aluminum fins, but hardcore copper fins that withstand abuse and increase cooling power.

To top it off, this kit uses a reservoir that conveniently fits into a 5.25-inch drive bay. Many similar products incorporate weenie 3/8-inch (or even skinnier) tubing, but Swiftech knows serious modders like the tough 1/2-inch stuff, so that's what you get.

Swiftech included a lengthy installation manual with the kit, but it was overloaded with irrelevant and unrelated information on other kits. Once we located the information for our kit and settled in, we finished the installation in about an hour, which, in our estimation, was far too long considering the limited number of parts we used.



It wasn't the waterblock installation that dogged us because the block utilizes your stock Intel CPU bracket. The radiator installation, however, was a Vicodin-worthy pain in the neck. Swiftech required us to screw quick-connect adapters into the radiator before we could install the hoses, and the adapters were extremely difficult to twist into place. Plus, the oversized radiator and 120mm fan were too big to cram into our case and thus found a home hanging off the back side of our box, a setup that will bother modders who want a more streamlined look.

Our struggles paid off, and we forgot our minor gripes after we tested this kit. It produced the lowest idling and working CPU temperatures of all our products. The waterblock itself became quite warm during our tests, but our CPU stayed nice and cool even when we applied some serious CPU Burn heat.

That said, we wholeheartedly recommend this revision of Swiftech's water-cooling kit. It's an expensive product, but if you're too pressed for time to assemble your own system, this one will do nicely.

Hard Drive Coolers

Hard drives keep spinning faster, and hotter, too. These coolers are designed to help keep the heat off of your high-RPM drive and hopefully make it last longer, too.

AeroCool HB-101 Fanless HDD Cooler

\$50 • www.aerocool.us



No matter their final heat dissipation performance, some hard drive coolers look rather, well, wimpy. That's not a problem for AeroCool's HB-101 Fanless hard drive cooler, which has the mean visage of a product out to put the hurt on heat.

The HB-101 is a three-sided cooler. It has heat-absorbing aluminum bars and a broad wave of heatpipe-imbedded aluminum fins across the top. Visually, the overall effect seems calculating and cold—the perfect environment for a too-hot hard drive. With your hard drive in place, the unit slides into a 5.25-inch drive bay.

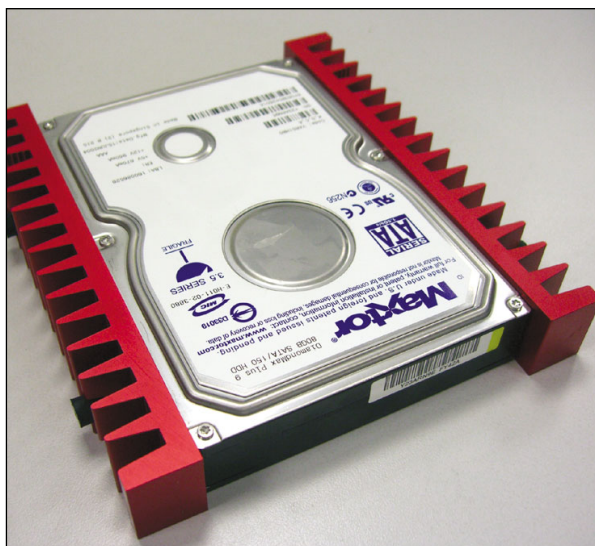
Our trial runs showed that the HB-101 does indeed reduce hard drive temperatures by a few degrees. Its performance, paired with sturdy parts and a menacing visual appeal, make this a good buy.

Cooler Master Cool Drive 5

\$50 • www.coolermaster.com



CPU Ranking: 0 = Absolutely Worthless 2.5 = Absolutely Average



Cooler Master's Cool Drive 5 offers nifty features you won't find in most hard drive cooling products. It's also one of the most fashion-conscious coolers on the market.

The Cool Drive is basically a giant aluminum box that acts as a heatsink for your drive. It fits into a regular 5.25-inch drive bay. The front of the Cool Drive has an intake fan, as well as two analog dials that help you monitor hard drive temperature and drive activity.

During our experiments, the Cool Drive did slightly lower our drive's working temperatures, and the enclosure helped reduce

noise, too. If you have a very hot or noisy drive, this is a good investment for you.

What's more, the dials on the front panel come with back lights, and with the touch of a button, you can choose from seven colors. For those late-night, substance-fueled gaming sessions, there's also a mode that rapidly cycles through each color with dizzying speed. The Cool Drive is a hardcore modder's delight.

Innovatek RaptorVibe

\$50 • www.innovatek.de



Innovatek's been in the hard drive cooling game for a while now, and its RaptorVibe is designed to kill both heat and noise in one swoop. The RaptorVibe looks like a sleek and trim version of a regular CPU heatsink.

There are two pieces of aluminum in the kit, one for each side of your hard drive, and they're equipped with rubber mounts designed to reduce vibration.

After you affix the heatsinks to your drive, you insert it into a 5.25-inch drive bay, and your drive is ready to go.

Our tests showed that in spite of its small size, the RaptorVibe really did help lower hard drive temperatures by a few degrees. And there's no doubt that Innovatek did a great job making this product easy on the eyes. It's a shame, really, that most drive bays will obstruct your view of the RaptorVibe's wicked profile.

The RaptorVibe comes in a variety of colors to help you coordinate your case's color schemes. It's an expensive but very cool addition to any modded setup where hard drive cooling is a concern.

Put It On Ice

As your PC's chips reach burnout performance levels that put them at risk of heat damage, high-quality cooling products will become increasingly critical. And if you're a serious enthusiast with a passion for overclocking, your cooling system won't be an afterthought—it will be a primary consideration as you construct a new system. With products like these, you'll know what sort of performance you can expect from a cooling system and which products make for the best investment. **CPU**

by Nathan Chandler

Some Like It Cool

Computer cooling products are among the hottest PC accessories on the market. We tested CPU heatsinks, watercooling kits, and hard drive coolers to help you find goods with the best chilling potential. In this chart you'll find the numbers our tests produced. ▲

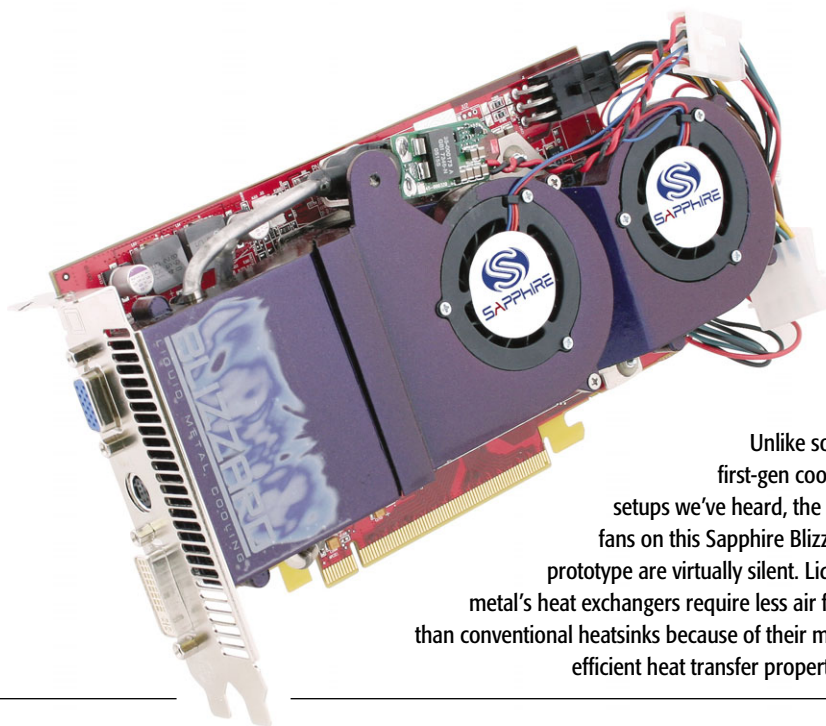
CPU Heatsinks	Surface temp (idle)	Motherboard Monitor CPU temp (idle)	Surface temp (working)	Motherboard Monitor CPU temp (working)	Noise level (decibels)
Aerocool Extreme	28	27	34	47	48
CoolerMaster Ultra Vortex	26	26	31	42	45
Spire Coolwave	29	28	34	49	58/71
Thermaltake Spark 7+	33	32	38	44	55/75
Watercooling Kits					
CoolerMaster Aquagate	24	25	31	34	67
G-Cooler Liquid Cooler	29	27	40	44	65
Innovatek Premium XXS	29	25	31	36	63
Swiftech H20-120-F (Revision 3a)	35	24	37	36	59
Hard Drive Coolers					
	External temp				
Stock Hard Drive	39				
AeroCool HB-101	31				
CoolerMaster CoolDrive 5	34				
Innovatek RaptorVibe	32				

(NOTE: All temperatures listed in degrees Celsius.)

CPU Ranking: 0 = Absolutely Worthless 2.5 = Absolutely Average 5 = Absolutely Perfect

The Metal That Flows

How Liquid Metal Will Cool Your Computer



Unlike some first-gen cooling setups we've heard, the two fans on this Sapphire Blizzard prototype are virtually silent. Liquid metal's heat exchangers require less air flow than conventional heatsinks because of their more efficient heat transfer properties.

Those of you who are into high-performance computing are doubtless aware of the thermal considerations in your PCs. CPUs and graphics processors can scale into temperatures that, to the touch, might as well be a nuclear reactor. The technology du jour in chilling PC components is watercooling. In nuclear reactors the pinnacle of cooling technologies is liquid metal, specifically liquid sodium or a sodium/potassium mix. Now, nuclear physics and PCs are about to meet when liquid metal cooling technology from Austin, Texas-based nanoCoolers hits stores later this year.

The Need For Liquid Metal

All semiconductor devices have some amount of electrical resistance. As a result,

power components dissipate some power in the form of heat energy. If this heat is not drawn away from the components quickly enough, the components' temperatures will rise so high that they'll be damaged. (Many modern processors include built-in instructions to shut down when temperatures get too high. This will usually avert damage but sure doesn't get much work done. Additionally, even short of the shut-down point, excessive heat can wear down circuitry and lead to premature failure.)

Passive cooling involves radiating heat away from the chip either directly into the air or indirectly by passing heat into a heatsink. Direct-to-air cooling was the norm up until Intel's 486 processor generation, at which point heat density became too high for unassisted air cooling, so

heatsinks were bolted onto the chips. A processor heatsink is a metal plate that has a smooth underside and a series of thin fins or spikes on its top. The heat from the processor's surface transfers to the plate and then into the fins or spikes. This greatly increases the amount of surface area exposed to the air, providing for more efficient dissipation. Early on, aluminum was the most prevalent heatsink material. But as chips have grown ever hotter, copper, which is more expensive but more efficient, has become a more common heatsink material. To keep cool air moving through the heatsink, a fan is generally attached to the top or side of the device, making it an active cooler.

Yet power densities per square centimeter on a processor continue to rise alongside the performance gains tied to Moore's Law. As Intel only half-jokingly showed in a demonstration in 2004, without significant changes in how processors manage power and dissipate heat, power density in CPUs will reach that of a nuclear reactor within the next couple of years, a rocket nozzle by the end of the decade, and ultimately the surface of the sun. A truly effective air-cooling product would need to take the heat from roughly 1 square cm on the processor and radiate it over 100 square cm. Because this is typically impossible for several reasons, the best result air cooling can generally achieve today is to cool 20W to 30W per square cm. Today's highest-performance CPUs exceed 100W, although the density per square cm during actual use is considerably less. Regardless, power efficiency within chips must be improved, but the same holds true for their external coolers.

Since the Intel 486 days, many alternatives to standard air cooling have emerged, most notably the use of heatpipes, which carry heat more efficiently into radiators and can handle up to about 40W per square cm, and watercooling, which uses circulating water rather than metal to convey heat to an external radiator. Watercooling is notably but not vastly more efficient than heatpipe-based cooling, and some studies have shown that air and water can achieve very similar results if the

user is willing to tolerate excessive fan noise. The biggest downsides to watercooling are its complexity to assemble (particularly in mounting the pump and hoses properly) and considerable cost, which is why PC watercooling exists almost entirely within the domain of enthusiasts. The time is ripe for a leap in cooling technology.

Enter Liquid Metal

The near future of performance computing may owe a huge debt to one man: Uttam Ghoshal, Ph.D., founder and CTO of nanoCoolers, former Master Inventor at IBM, and holder of more than 80 patents in advanced technologies. Ghoshal looked at the chip-cooling market and saw several deficiencies in current chip-cooling designs. The primary problem with watercooling from his perspective is that water is a poor thermal conductor and doesn't pull heat from the processor plate very efficiently. To overcome this microchannels (tiny conduits narrower than a human hair etched into silicon) can be employed. In theory microchannels can yield cooling sufficient for up to 1,000W per square cm, but pressuring water through the channels is its drawback. Microchannels require so much pressure that relatively heavy-duty pumps are required.

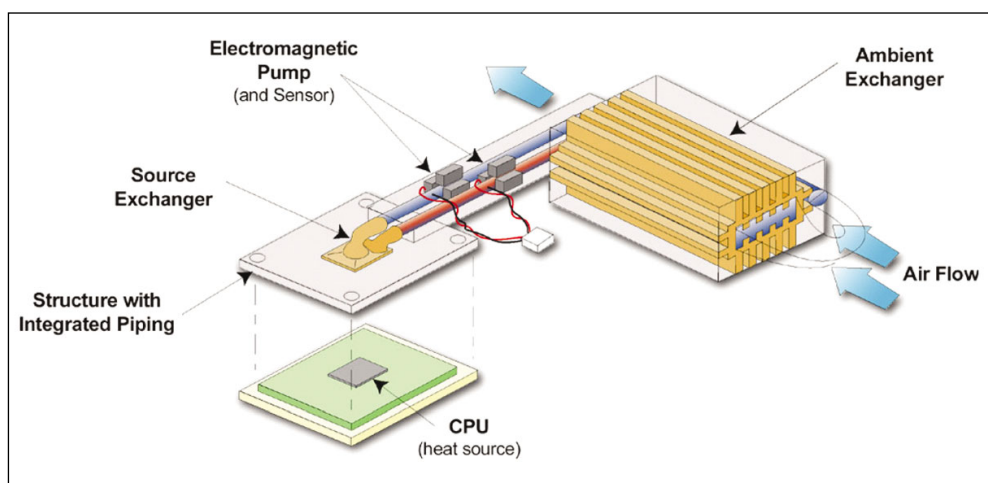
Liquid metal can solve both of these problems. Mercury is the most famous of the metals that are liquid at room temperature, and in fact, mercury's conductive properties make it a candidate for this type of cooling. However, mercury's toxic properties are equally infamous. Cesium is another room temperature liquid metal, but it is too reactive for common use. Ghoshal turned to gallium, which melts at 85.6 degrees Fahrenheit, doesn't evaporate, sports appropriate electrical and thermal conductivity (gallium is 65 times more thermally conductive than water), and has the widest liquid-state temperature range of any element. After considerable experimentation and refinement, Ghoshal and nanoCoolers hit upon an alloy comprised

of gallium, indium, and other elements to enhance the liquid metal as a semiconductor coolant. All of this adds up to a material well-suited to ferrying heat away from a processor surface provided you can keep the liquid moving.

Because liquid gallium alloys are good electrical conductors, the material can be moved with a silent electromagnetic pump that involves no moving parts. The pump nanoCoolers devised is little more than magnets, two electrodes, and a yoke. When power is applied to the electrodes, the pump pushes the liquid with surprising force through the closed loop pipe system. In principle this is very similar to cooling systems in some nuclear reactors, but nanoCoolers' implementation marks the first practical application of the system in a very small form factor.

bringing liquid-metal cooling to market, Sapphire is the only company as of this writing that has publicly announced adoption of the technology. The company will debut liquid-metal cooling on its top-end ATI-based graphics cards and brand them under the name Blizzard.

The Sapphire image you see in this article is of a preproduction implementation done on a card with the ATI Radeon X850 chip. Sapphire had announced that liquid metal would debut on X850 XT and XT Platinum Edition cards, but we have it from inside Sapphire sources that the company is "moving [liquid metal] to the next ATI chip," presumably the next-generation R520 GPU that ATI revealed behind closed doors at the E3 event last May. The latest industry buzz indicates that R520 will launch in the third quarter of 2005.



nanoCoolers' basic design for a liquid-metal CPU cooler looks at first glance like a notebook heatsink. The difference is that the liquid metal in the tubes and the electromagnetic pump pushing it do a better job of transferring heat and require less power.

Thus the entire liquid-metal cooling loop resembles the system used in watercooling, only now the liquid material is far more thermally conductive, the pump is more efficient and silent, and as such, the fan used at the heat exchanger, the metal fin array at the end of the loop that transfers heat into the air, needs to work far less, reducing noise levels.

Headed For Market

Although nanoCoolers has many industry partners lined up who are working on

The next question is how much liquid-metal cooling will cost. "Free' is what everybody would like to cool their CPUs with, and obviously liquid metal is costly," says Gary Baum, vice president of marketing and business development for nanoCoolers, as well as holder of six patents in CPU system design. "Initially, it will find itself in the enthusiast part of the marketplace. Then, as we introduce our thermoelectric coolers, we can address ever-increasing and broader portions of the marketplace. We know that the first thing

anyone will say is that a hunk of copper sitting on top of a CPU costs \$10. At retail with a bunch of fins, it's maybe \$40. Our solution costs more, so cost is always a driving goal."

The thermoelectric coolers to which Baum alludes is another technology nanoCoolers is prepping for release. In effect, it is an update of Peltier cooling, which combines special metal elements with electricity to serve as a heat pump, and now applies the Peltier effect in a thin film-type format. Thermoelectric cooling is traditionally capable of handling 70W per square cm. nanoCoolers' approach takes the same efficiency and shrinks it by 30 times, making it small enough to sit right on a CPU die without a bulky, expensive apparatus. Baum expects liquid metal to stay at the higher end of the market while thin-film thermoelectric products fill in the mainstream.

Going Forward

Liquid-metal cooling promises far greater thermal efficiency than conventional heatsinks, with less bulky copper required. It also has none of the orientation issues that plague watercooling and no risk of leaks. Because of these factors, liquid metal seems a sure bet to capture the enthusiast cooling market for CPUs, GPUs, and perhaps even northbridge chips. Of course, don't count on seeing the name nanoCoolers very much. The company produces strictly on an OEM basis. In fact, the pages at nanocoolers.com that used to detail liquid-metal technology have vanished, most likely so that attention will fall on the industry partners actually marketing liquid-metal products.

"Ultimately," says Baum, "this transport is so efficient, I wouldn't be surprised to see totally silent or near-silent solutions. We could perhaps put an ambient exchanger outside of the PC box with little to no airflow and achieve some very desirable noise benefits. That's probably the next thing to look at."

Beyond chip cooling, nanoCoolers is targeting projectors, which use extremely hot LED arrays or xenon or mercury bulbs and are often limited in their brightness because of thermal restrictions.

Q&A With Uttam Ghoshal, Ph.D.

PCM: How did you get into nanocooling?

UG: Early on, I specialized in cryogenics. I did my Ph.D. from Berkeley, and I was pretty much in low-temperature CMOS and superconductivity for a while. I was an associate at IBM, and then, when the new IBM processors came into being, like the POWER4 and the POWER6, I was on POWER4 as one of the main designers. This was somewhere around '97, and it was getting clear that future processors would be having lots of thermal management problems. And because I had a cryogenic background, IBM management thought, 'Hey, this guy is perfect for the job.' They moved me into looking at how to solve cooling for hot chips, like hot processor chips within an IBM. We went through different cycles, including making refrigerators for the high-end mainframe, then moved into more multi-processing. That's where I started working on thermal

electrics and other interesting solutions. We had a lot of ideas about making solid-state refrigerators. That was slightly off of IBM's main line of thinking. Refrigeration was not an industry that IBM would like to get into. And I was passionately in love with that, so at the time I decided to start this company. That was May 2002.

PCM: What makes you so passionate about it?

UG: What we are doing in computer systems is just generating a lot of entropy. Entropy of data has a direct relation to heat. I've been passionate about a lot of these energy-based solutions, different kinds of refrigerators, different kinds of thermal solutions, for a long time. But as soon as we started nanoCoolers, it became apparent that, hey, the more exciting challenges are in computing systems, which need solutions very quickly.

PCM: So you gave up on refrigerators?

UG: No, this is a pursuit that we are still doing. But as soon as we talked about doing the refrigerator, we saw that removing heat from the hot side of the refrigerator is similar to what is needed in the process of cooling processors. You want to take the heat and reject it efficiently and ambiently. That was the birth of the liquid metal, actually.

PCM: With 45 patents and counting under nanoCoolers, do you have the intellectual property cornered in this market?

UG: There are a number of Ph.D.s here working quite hard on the right formulation, the right pump design, and so on and so forth. And not many are comfortable using these liquid metals yet. It would be very difficult for someone else to replicate this, let alone work around the patents that have been put into place. ▲

Liquid-metal cooling could usher in a whole new level in projector performance.

Shortly before going to print, we learned that nanoCoolers had just received a new set of lab results on the performance of its thin-film thermoelectric technology. The company is staying mum about the specific numbers, but with first-generation liquid metal more or less finished, nanoCoolers is now shifting the bulk of its development efforts over to TEC. In PCs the likely scenario would be that nanoCoolers' thin film replaces today's bulky, expensive aluminum

and copper heatsink plates and radiators while still relying on conventional air cooling to dissipate heat on the film's hot side. In higher-end systems thin film would link directly with liquid metal, which will do a far more effective job of moving that heat from the CPU to the PC's exterior than air, heatpipes, or water.

Is there liquid metal in your future? Chances are you'll know the answer by spring of 2006. **CPU**

by William Van Winkle

Arctic RAM

Make Your Memory Chill Out

We're sure your CPU appreciates the air conditioner-sized heatsink-and-fan combo that you've strapped to it. Maybe your water-cooled GPU is letting you cajole a few more frames per second out of *Half-Life 2*. Meanwhile, your poor memory is running so hot that it's two eggs and some shredded cheddar cheese away from cooking up some delicious *huevos rancheros*.

Big-ticket items such as watercooling kits and phase-change systems often receive the lion's share of attention, but PC memory is another culprit you should tackle in your war on unnecessary heat. Because adjusting a system's FSB is probably the most common method of overclocking a CPU, you're simultaneously putting additional stress on your system's RAM. In turn, this generates more heat and can lead to system instability.

Like chilling your CPU or graphics card, there are a host of available options to meet your RAM cooling needs. Both passive and active cooling equipment exists, and making the right decision could come down to the number of sticks you want to stuff in your system.

Of course, the key players in the high-end RAM business already do a respectable job of absorbing some of the heat high operating frequencies generate. It's hard to find premium memory that isn't pre-jacketed with its own heat spreader. Aside from being roughly on par with third-party heat spreaders, the heat spreaders are bonded to the memory chips with a virtually permanent thermal tape; removing them can be time-consuming and usually unnecessary.

But what about RAM that's currently in the buff (not to be confused with buffered, unbuffered, or a particularly good attempt at a witty pun)? Having some sort of cooling device attached to your CPU is mandatory (go ahead, give it

Like chilling your CPU or graphics card, there are a host of available options to meet your RAM cooling needs.

a shot sans heatsink), but how much difference can a thin slab of molded copper slapped to a stick of K-Mart-brand RAM make? What's the real deal, and what's marketing-speak for "fancy window dressing kit with a high profit margin"? We'll test a flock of products to see if there're any grade A poultry or just a lot of jive turkeys.

Decisions, Decisions

Just like memory itself, there are many manufacturers with a bonanza of products to court your George Washingtons, Abraham Lincolns, and their other green presidential friends. You can party with passive cooling or ally yourself with active cooling. And once you've made that decision, do you want your memory's new duds carved out of aluminum or copper?

Heat spreaders are one example of passive cooling. The biggest difference between passive and active cooling is that passive cooling has no moving parts. The

passive cooling products we tested were either heat spreaders or heatsinks, or a combination of both. While heat spreaders are essentially limited to keeping memory modules cool, some smaller heatsinks are a little more versatile. Not only can you affix them to RAM chips, but these tiny heatsinks will also work with video card memory and any motherboard chips that generate heat. Most of the products in our shopping cart used passive cooling.

There seemed to be far more passive cooling choices for our RAM than active cooling, but we were able to find a few active cooling products. Both of our active coolers used 40mm fans to give unwanted hot air a friendly push out the door. Neither apparatus seemed to limit our ability to fill every DIMM slot with a stick of memory—a definite plus.

Finally, there's the perennial aluminum vs. copper debate. It's a war of words tantamount to Pepsi vs. Coke, Chevy vs. Ford, and "Tastes great!" vs. "Less filling!" Different modding gurus will say with the same amount of conviction that one material is better than another. Without dusting off our old science textbooks too much, heat transfers through one of the following three methods: conduction, convection, and radiation. RAM cooling products use conduction, which refers to transferring energy (heat) from a hotter object to a cooler one. For our purposes, RAM cooling devices absorb heat from memory chips.

Hence, what material do you want on your side when you go into battle against overheating? You might think the most important factor is a material's specific heat capacity, which is how much energy is required to raise a material's temperature by a specific amount. Aluminum's specific heat capacity is 900J/kg*K, and copper has a specific heat capacity of 386J/kg*K. Based on this, you might say that aluminum is a better material because it can absorb more energy before its temperature increases. It's not that simple.

Thermal conductivity is a better measure of a material's cooling effectiveness.

Thermal conductivity quantifies a material's ability to conduct (read: transfer) heat. Copper's thermal conductivity (401 W/m*K) is nearly twice as much as aluminum's (237 W/m*k); theoretically, even though the same amount of energy will raise copper's temperature more, copper is superior at actually transferring heat away from a hotter substance.

If simply taping a solid block of metal to your memory was an effective cooling solution, thermal conductivity might be the end-all, be-all factor. But physical design matters, too. This is especially important with CPU heatsinks, but it plays a role with other cooling products, too. It's also harder (and consequently more expensive) to machine copper than aluminum, so you'll pay a premium for copper cooling devices.

How We Tested

The rig. Our test system included a 1.8GHZ AMD Athlon 64 2800+ CPU and Gigabyte's K8VXP motherboard. The K8VXP has three DIMM slots and supports DDR 200/266/333/400 RAM. We brought Thermaltake's Hardcano 13 and its four temperature probes along for the ride; it would help us take temperature readings of our RAM cooling heroes.

The RAM. To test our motley band of cooling brothers, we used a 512MB stick of PC3200 (2.5-3-3-8) Corsair Value Select RAM. Like we mentioned earlier, we don't recommend prying off the heat spreaders of your uber-expensive, low-latency RAM so you can slap on essentially the same product from a different manufacturer. Stick with using these products on RAM that doesn't have the benefit of additional cooling hardware. After testing each product, we cleaned the RAM chips with Arctic Silver's ArctiClean cleaning system.

The run. After connecting the Hardcano's 13 heat probes, we fired up our test PC and let it idle for five minutes before taking our first temperature reading. We used two heat probes and averaged the temperatures of the probes. Then we put our memory under a load with PCMark04's Memory test and took another temperature reading. Next, we prodded our FSB 20MHz higher—a 10%

increase—and took idle/load temperature readings again.

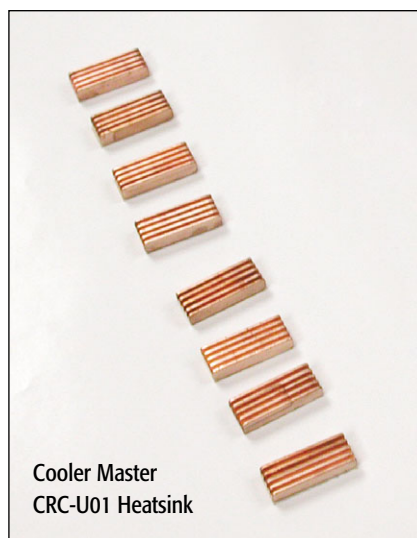
Although using the Hardcano 13 to take temperature readings is a little more precise than using the "Yowza, this feels hot!" method, it's far from perfect. Like a CPU's heat spreader, heat isn't distributed evenly across the entire memory module, so some areas will be hotter than others. Plus, because taping the temperature probes directly to the RAM chips and applying a cooling product would likely create a crushed diode sandwich, we taped the probes to the outside of the cooling products. As result, we were recording the temperatures of the cooling products themselves and using these readings to infer how much heat a particular product had absorbed, not how cool our memory modules were.

Cooler Master CRC-U01 Heatsink

\$11 • www.coolermaster.com



Vantec and Cooler Master's heat spreaders looked virtually identical, but we noticed a few more dissimilarities between Thermaltake's and Cooler Master's RAM heatsinks. Thermaltake's heatsink has fins that are longer than Cooler Master's heatsink; Thermaltake's heatsink fins are horizontally oriented; and Cooler Master's are vertically oriented.



Cooler Master
CRC-U01 Heatsink

Cooler Master CRC-U02 Heat Spreader

\$11.95 • www.coolermaster.com



We paid almost twice as much for Cooler Master's copper heat spreader as we did for Vantec's offering, so we were curious to see if variations in the machin-

Cooler Master CRC-U02
Heat Spreader



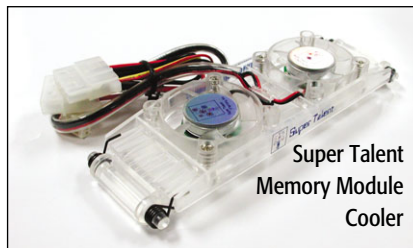
ing process and differences in the copper itself might make one copper heat spreader, which looks remarkably similar to the other, a better product.

Super Talent Memory Module Cooler

\$19.99 • www.supertalentmemory.com



Super Talent must have decided that active cooling shouldn't be limited to CPUs, graphics cards, and northbridges.

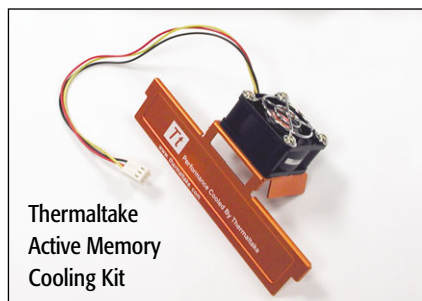


Super Talent
Memory Module
Cooler

Its Memory Module Cooler sports dual 40mm fans spinning at 4,500rpm to sweep that sultry air away from your memory modules. It's compatible with most DIMM slots and, because it doesn't attach itself directly to the memory modules, you can use a passive cooling product to form an active-passive RAM cooling tag team. As an added bonus, the Memory Module Coolers provide a sweet light show when you fire them up, giving you one more reason to take the plunge and cut that case window you've always wanted.

Thermaltake Active Memory Cooling Kit\$7.79 • www.thermaltake.com

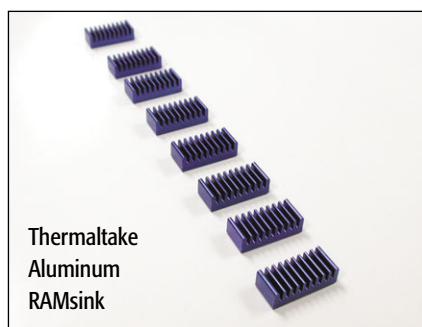
Thermaltake took our recommendation of combining a heat spreader with



Super Talent's Memory Module Cooler and produced its Active Memory Cooling kit. A heat spreader and 40mm fan combination are fused together so that the fan will sit over several modules. Super Talent's Memory Module Cooler has two fans, but Thermaltake's fan sports a sharp chrome grille.

Thermaltake Aluminum RAMsink\$5.99 • www.thermaltake.com

Tiny heatsinks, such as Thermaltake RAMsinks, are a lot like utility players on a sports team. Although they're designed to put memory chips on ice,

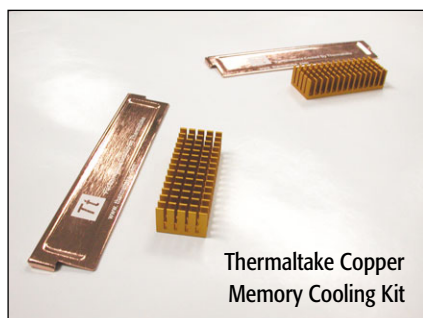


you can attach them to a number of different motherboard components. Slap a couple on your motherboard's south-bridge to dissipate heat. And if you really have a fever for these tiny heatsinks, throw them onto anything from a

Gigabit Ethernet chip to a Silicon Image SATA controller.

Thermaltake Copper Memory Cooling Kit\$29.98 • www.thermaltake.com

Not satisfied with using merely a heat spreader or heatsinks, Thermaltake upped the ante with its Memory Cooling Kits.



Aside from including positively gargantuan copper heatsinks (these bad boys cover far more surface area than the RAM chips), you can clip copper heat spreaders to the heatsinks for more heat dissipation. Even though the Copper Memory Cooling Kit was one of the most expensive passive cooling products we bought, we purchased it so long ago that you should be able to find it for much cheaper than \$29.98.

Thermaltake Copper RAMsink\$9 • www.thermaltake.com

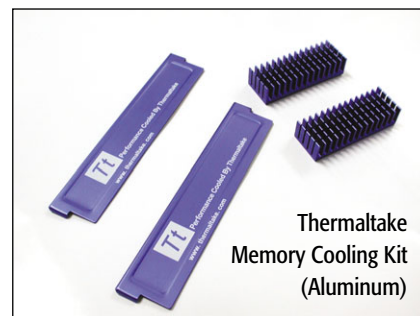
Just as Vantec offers two flavors of heat spreaders, Thermaltake's RAMsink has a copper alternative to the standard



aluminum fare. You should be aware that Thermaltake's RAMsinks are slightly wider than the heat spreaders we tested; you may not be able to use all of your DIMM slots if you're using certain RAM heatsinks on both sides of double-sided memory.

Thermaltake Memory Cooling Kit (Aluminum)\$7.99 • www.thermaltake.com

Just as big and burly as the Copper Memory Cooling Kit, Thermaltake's Memory Cooling Kit is an aluminum alternative. It's a little cheaper than the copper version, but it still has the same



dimensions. Because the heatsinks are so large, you may have to make compromises with the amount of RAM you can install.

Thermaltake TrueLight Memory Heat Spreader\$16.99 • www.thermaltake.com**Thermaltake True Light Memory Heat Spreader**

This is *the* cooling product for anyone who has a windowed case. It's a little pricey for a single heat spreader, but it definitely

put our other heat spreaders to shame in terms of flash factor. A microprocessor controls five LEDs that light up “Thermaltake” in eight ways, effectively demolishing productivity for anyone with a short attention span. The illumination might not make your RAM cooler, but it might make you look cooler. Or maybe not.

Vantec DDR-A1A Aluminum Heat Spreader

\$4.55 • www.vantecusa.com



The white bread of RAM cooling products, Vantec’s DDR-A1A is a basic aluminum heat spreader that is compatible with all standard SDR and DDR SDRAM. If you’re applying DDR-A1A heat spreaders to single-sided RAM, be sure to use the included adhesive sponge to fill the space between the heat spreader

and the side of the memory module without any RAM chips.

Vantec DDR-A1C Copper Heat Spreader

\$6.99 • www.vantecusa.com



The Vantec DDR-A1C is the slightly pricier copper twin of the DDR-A1A, so with the exception of the cooling



material, it has the same dimensions as Vantec’s aluminum heat spreader. Unlike the DDR-A1A’s rather drab matte finish, the DDR-A1C is polished to perfection.

Chilling Results

Because of the difficulties in testing the products as we described above, our results were expectedly semi-scientific. We’re comfortable saying that these products made *some* sort of difference, but it’s virtually impossible to quantitatively

determine how helpful a particular heat spreader or heatsink was.

We can say with certainty that our active cooling products made more of a difference than the passive coolers. We taped the temperature probes to two RAM chips and took temperature readings without any cooling products. Next, we clipped on Super Talent’s Memory Module cooler and noticed across-the-board temperature drops; it was particularly effective when our RAM was under a load. We also disabled the Thermal Active Memory Cooling Kit’s fan and saw the heat spreader’s temperature rise.

One final word of caution: if you’re concerned about tight squeezes in your case (particularly SFF cases), stick with heat spreaders. Even placing smaller cooling devices such as tiny heatsinks can add bulk to your RAM that could limit the amount of DIMM slots you can use. Thermaltake’s Memory Cooling Kits and Active Memory Cooling Kits were particularly gargantuan.

If you’ve already invested a sizable chunk of change in your system’s RAM and don’t want to drop more cash on upgrading to more expensive RAM, consider buying a few cooling products. It’s a hot idea that should keep things cool. **CPU**

by Vince Cogley

Some (Don’t) Like It Hot

Occasionally, our tests yield results that leave us scratching our heads. Copper should be the superior material, but you’ll notice that in a few instances, an aluminum cooling product seemed to absorb more heat than its copper counterpart. Still, we thought the temperatures below indicated copper is usually better. We also thought active cooling products generally lived up to their claims.

	Idle (Degrees Celcius)	Load (Degrees Celcius)	OC Idle (Degrees Celcius)	OC Load (Degrees Celcius)
No cooling products	33.35	39.25	34.9	40.15
Cooler Master CRC-U01 Heatsink	31.88	36.1	32.5	37.25
Cooler Master CRC-U02 Heat Spreader	33.9	36.25	34.5	36.9
Super Talent Memory Module Cooler	33	36.25	33.33	36.75
Thermaltake Active Memory Cooling Kit (fan active)	29.5	33	30.85	33.85
Thermaltake Active Memory Cooling Kit (no fan)	32.15	36.15	33	37.15
Thermaltake Aluminum RAMsink	33.3	34.65	33.7	35.5
Thermaltake Copper Memory Cooling Kit	31.1	36.35	32.65	36.85
Thermaltake Copper RAMsink	32.4	34.75	33.5	35.5
Thermaltake Memory Cooling Kit (Aluminum)	32.65	36.35	33.5	36.7
Thermaltake TrueLight Memory Heat Spreader	31.5	35.5	32.65	36.35
Vantec DDR-A1A Aluminum Heat Spreader	33.3	36.35	34.25	36.9
Vantec DDR-A1C Copper Heat Spreader	31.25	35.25	33.85	36.85

CPU Ranking: 0 = Absolutely Worthless 2.5 = Absolutely Average 5 = Absolutely Perfect

Chill Chat

Cooling Q&A



It doesn't matter what type of processor, video card, or hard drive is in your PC—it will generate heat, and heat is your PC's worst enemy. Today's processors vary in their maximum operating temperature from 60 to 95 degrees Celsius. Because this is a large range, check the specifications of your processor to find the temperature that's best for your machine. Lower temperatures are always better, so you'll never reach a temperature that's too cold. Condensation, however, can be a factor that you need to deal with if you use an exotic (and very cold) cooling system. Shoot for temperatures between 40 C and 55 C. These operating temperatures can vary depending on the system load. Many questions arise when it comes to combating the heat in your PC and maintaining a reasonable operating temperature. Let's discuss a few options below.

Q What size of tubes should I use in my watercooling system?

A If you're building a custom system and have free reign to choose the tube size, consider these factors. Tubing that has a 1/2-inch



When setting up a watercooling system, measure twice and test fit all components before you fill 'er up.

i.d. (inside diameter) has greater potential to cool your system due to better water flow and, therefore, may give you a few extra degrees of coolness. On the downside, 1/2-inch tubes are generally stiffer than smaller tubes, which can make them harder to set up and harder to work around when maintaining your system. Additionally, some cases don't have the space to accept 1/2-inch tubing without putting undue pressure on other components.

On the other hand, 3/8-inch i.d. tubing is easier to bend and work with and is less likely to interfere with the airflow in your case because the tubes are smaller. If your case has space constraints, 3/8-inch tubing is a good way to go. Also, 3/8-inch tubing is generally quieter and faster to purge. The biggest downfall to 3/8-inch tubing are less water flow due to smaller tubes, so it may not cool as well as 1/2-inch tubing (a watercooling system's overall cooling ability depends on many factors, not just the hose size). There is also 1/4-inch tubing available, though it's not as popular as the other two choices we mentioned.

Q I'd like to create more air flow through my case, but I don't want to use a lot of noisy fans. What should I do?

A Most fans that you'll find in your computer are 80mm fans. There are a variety of other sized fans available, some of which have greater cooling capacities. And some 80mm fans have greater cooling capacities than others, although they may be noisier. The cooling capacity of a fan is measured by the amount of air it can generate, measured in CFM (cubic feet per minute). There are plenty of noisy 80mm fans out there with high CFM rates. Because you want a fan that doesn't make your computer sound like a jet plane, consider a 120mm fan. Many 120mm fans have as much as twice the CFM rating as regular 80mm fans but aren't as loud. Before purchasing a 120mm fan, make sure there's room in your case for it. Some cases have 120mm fan openings, but many do not. If your case doesn't have one, that's OK, you can mod your case to make it fit. A fan at the top of the case will be good for exhaust, and a fan in the left side panel is one way to bring fresh air in.

Q What's a good way to cool the RAM on my video card?

A Many users have found that attaching small copper heat-sinks to the RAM chips works

Insulate Your Chips

Arctic Silver 5 (\$8.35 for a 3.5-gram syringe; www.arcticsilver.com) is a great thermal compound that can give you a few extra degrees of cooling. Because Arctic Silver contains silver particles, it can become slightly conductive if it encounters dust or metal particles. Therefore, keep the thermal compound away from the memory and motherboard traces and pins. You don't need to use very much Arctic Silver thermal compound for it to be effective. An amount equivalent to a grain of rice will do the job.

quite well. Make sure you find heatsinks of the right shape and size, whether they be rectangles or squares, so they fit your memory well. Use thermal epoxy to mount the heatsinks to the video card. A heatsink alone will not solve all your memory's heating problems; make sure you also have good case ventilation to prevent heat from building up over the heatsinks, which can cause instability or damage to the video card.

Q Should I get a hard drive cooler?

A That depends on your case setup. The best way to cool your hard drive is with properly placed case fans. If you have a case with a fan bay right in front of the drive, that's ideal. If not, consider modding your case to put a fan right in front of the hard drive. If you're unable to cool your hard drive with fans, then it's worth considering a dedicated hard drive cooler. There are many options available on the market, with some featuring small 40mm fans and others featuring heatsinks. The Cooler Master CoolDrive 4 incorporates 40mm fans, whereas the Vantec HDC-502A has a heatsink and two fans. The high-end drive coolers usually feature both a heatsink and a fan.

Q I'd like to replace the heatsink on my processor with a better one. What's a good way to remove the old heatsink compound?

A Removing old heatsink compound can be a bit tricky. One way to remove the old heatsink compound is by scraping the processor with the edge of a credit card or razor blade. If you don't trust your steadiness, try putting a little bit of rubbing alcohol on a lint-free cloth and scrubbing the old heatsink compound away. As long as you have your case open and the processor free, you might also want to take this time to clean the dust that has accumulated in the system.

Q Can I use regular tap water in my watercooling system?

A Keep in mind that regular tap water has many impurities, including minerals, chemicals, and metals that can cause problems in a watercooling system. That said, you can use regular tap water, though it's not ideal. If you have an all-copper and brass system, you'll probably be OK with pure tap water, but you should add a few teaspoons of bleach or another antifungal solution to prevent algae growth in your system. Systems made of aluminum, iron, steel, or zinc shouldn't use regular tap

water because corrosion can occur. Distilled water is best for watercooling systems because it has fewer impurities and is less likely to cause corrosion. Regardless of which type of water you use, it's always a good idea to add a corrosion inhibitor to your solution.

Q I'm thinking of installing a Peltier cooling system. How can I avoid condensation inside my case?

A Anytime you cool something below the surrounding air temperature, the colder object will experience condensation. The best way to avoid condensation in your Peltier system is to properly insulate the components. Popular choices include rubber, foam, closed-cell neoprene, and silicone. To seal around the CPU, you can use rubber gaskets and an RTV (room temperature vulcanizing) sealant. RTV sealant can also be used around the edges of your Peltier. For further insulation, you can use dielectric grease on the socket of the processor. You can also use Pulse-width modulation to control the Peltier power and avoid temperatures that can cause condensation.

Q One of my fans seems to be running rather sluggishly. What can I use to lubricate it?

A If you've already cleaned the fan to rid it of dust and grime, try using a drop of medium machine oil to lubricate the fan. This is better than using a lubricant such as WD-40. The purpose of WD-40 is to loosen stuck parts, prevent corrosion, and displace water. Given that these are not the types of problems facing computer cooling fans, it's not the right type of lubricant to use. A lubricant such as 3-in-1 household oil or sewing machine oil that's specifically made for components that move continuously is much better. It may help to quiet the fan down a bit too. **CPU**

The Liquid PC

Watercooling will keep your system cooler than forced air. The Koolance PC3-720BK (\$394.99; www.koolance.com) is a watercooling system that can dissipate up to 700W of heat. If you're planning to use multiple cooling blocks, you should install your system components first, test fit each block, and then test fit the hoses before you fill and bleed your system. Following these steps will help reduce the possibility of errors. It's a wise idea to pair this cooling system with a high-quality power supply that provides at least 450W of power.

by Jennifer Johnson

Case Cutters

From Chassis To Classy

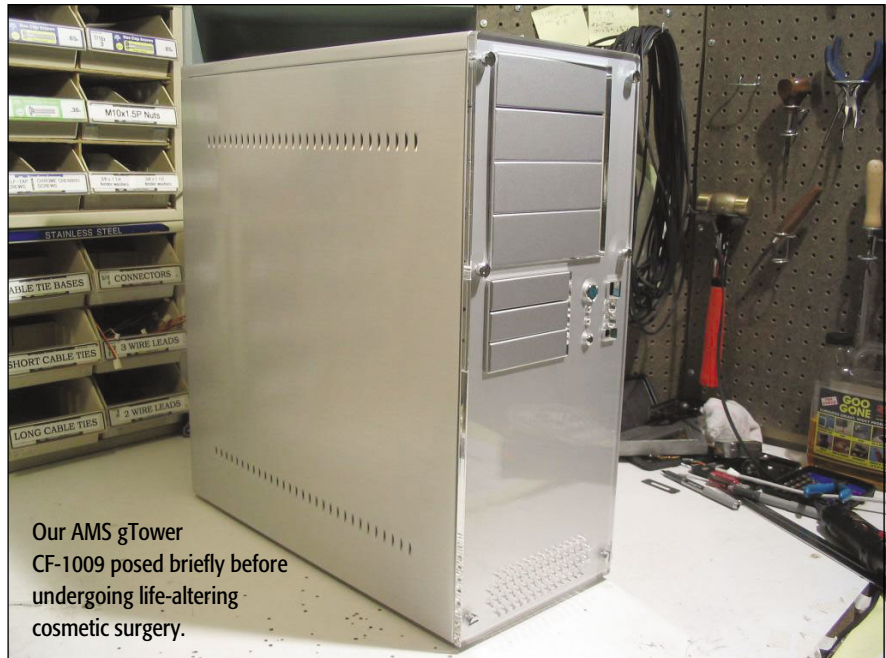
Computer case modding is a decidedly uncommercial endeavor. Instead of mass-producing cases, the modder transforms a retail chassis into a unique enclosure that is as much artwork as it is device. Some modders skip the standard case altogether and build an enclosure from scratch. In either case a modder mixes art and function to bring his vision to life.

At least that's how the theory goes. We've seen more than a few mods that merely reflected a lack of talent. Some PC enthusiasts simply don't possess the appropriate skills or have access to the right tools. They know what they want, but they can't bring the image to life when cutting into a computer case. Time is another mod killer; few people can set aside dozens of hours every week to create a custom case.

We kept the talent issue in mind when we planned our next *PC Modder* cover. A few *CPU* staffers are handy with a Dremel, but we wanted a *PC Modder* cover rig that boasted more than some fancy cutwork. Our vision: a system that sported mind-blowing aesthetic and functional mods, as well as a theme that brought the mods together. We're almost as passionate about automobiles as we are about computers. (After all, few machines scream power and beauty like a souped-up muscle car.) Thus, we turned to a professional modder who could do justice to the high-end components we planned to use. In the next several pages, we'll show you from start to finish how the modder created a cover-worthy rig. (Read more about our system's guts in "Born To Run" on page 92.)

Going Pro

As modding broke out of the realm of the obscure hobby and leapt into the PC



Our AMS gTower CF-1009 posed briefly before undergoing life-altering cosmetic surgery.

enthusiast mainstream, a small number of experienced modders stepped up to fill the gap between vision and ability. These modders have the talent and tools to create highly customized and polished computer cases. One of the best-known professional modding shops in the country is MNPCTECH, a Minnesota-based firm that doubles as an online modding supplies retailer.

We checked out the mod shop's gallery of completed projects and liked what we saw, so we spoke with Bill Owen, who owns MNPCTECH. He agreed to build a muscle-car-themed chassis and suggested a theme based on the Corvette Stingray. Owen proposed some heavy-duty mods, such as ripping out the front of the case to add some 120mm fans, creating a front panel that resembled a Stingray's cowl-induction style hood, adding handles and customized exhaust fans, and airbrushing a logo onto the side panel.

"Great," we said. "And by the way, can you do it in a month?"

Chassis

Although we had already selected most of the rig's components, we didn't have a chassis. Customers sometimes send their own cases to Owen, but we asked him to choose the canvas for this piece. He selected the AMS gTower CF-1009 (we've seen the case online for about \$99), which won't win any beauty contests on its own. "The more plain-Jane, the better," Owen says. "In this case the AMS gTower CF-1009 is about as simple as you can get."

He's not kidding. As Owen pointed out to us, the front bezel's only decoration is a removable acrylic plate that has holes in front of the external bays. The case's interior is almost as simple, but it has a few notable features, including two 80mm front-panel fans that sit just under the three external 3.5-inch bays. In back



Traditional hinges can't impress the way these hinges do. The plastic frame is from an Addtronics case bezel. Owen cut the bezel from the Addtronics case and modded it to fit the AMS gTower.

the enclosure sports a 120mm fan and has two fan grilles for optional 80mm fans just above the PSU. Thanks to the room above the power supply, the case is particularly radiator-friendly.

Front-Panel Fans

Owen saw an opportunity for more cooling power when he looked at the 80mm fans in the front of the system's case. "You've got enough space where you can cut out the front portion of the chassis, put in a 12 x 8 plate in there, and then put two 120mm fans in front," says Owen.

Owen removed the 3.5-inch bay cage and then cut out the lower portion of the front panel with his Dremel. If you try this on the average full-tower ATX case, keep in mind that you'll lose the 3.5-inch bays. We didn't plan to put any devices in the bays, so Owen was removing a useless cage to make way for a much more useful fan. Next, Owen grabbed a sheet of 18-gauge steel and cut a faceplate that was slightly taller and wider than the hole in the front of the chassis. He drilled 1/8-inch mounting holes along the edges and then mounted

it to the chassis with pop rivets. Next, he used circular 120mm fan grilles as guides, marking the two fan holes and eight smaller fan mounting holes.

Owen's large hole punching device requires a small hole in the center of the circle, so he drilled a rough hole and then finished the job with a big Greenlee manual

punch. "The beauty of using a hole punch is that cuts are precise and clean," Owen points out. "They look laser cut. You don't have to debur the edge of the cut like you would with a hole saw."

Of course, even clean edges have an unfinished look, so Owen pushed rubber vibration-muting grommets into the fan mounting holes and then cut black U-channel molding for the edges of the large fan holes. But he didn't attach these right away, as the chassis had a date with the powder coater.

Powder Coating

Even pro modders rarely have the tools to handle two of the more popular coloring methods: anodizing and powder coating. Although anodized surfaces are extremely durable, the process is difficult and costly. Owen estimates that he would have paid double the cost of powder coating to anodize our chassis. Owen contacted the powder coater he's worked with for years and chose a three-layer process that includes a metallic base coat, the candy-apple red that makes the interior of our Stingray such an eye-catcher, and then a clear coat. Owen used a pen to flag the motherboard standoffs, which the powder coater plugged with silicone before starting the process.

The cardboard Stingray hood prototype let Owen outline cut patterns on both the Addtronics bezel and the steel sheet.





That's right: This radiator requires three gargantuan fans. Who said watercooling was quiet?

A New Front Bezel

As we mentioned earlier, the front panel of the AMS gTower CF-1009 is as flat as a board, but Owen had no trouble spicing up the unexciting front, thanks to a secret he'd stumbled across earlier. "Two years ago I was just goofing around and I had an Addtronics (6896A) and an AMS, and I thought 'you know, they look awfully similar,'" Owen says. "And I took that Addtronics bezel, and I lined it up to the AMS; It had the same dimensions." When Owen planned the Stingray hood and the system's retractable cover, he realized that he could modify and

paint the 6896A's bezel to create a new front bezel for our rig.

Retractable Cover

Owen started the retractable cover that conceals our rig's water reservoir and DVD-RW by cutting the 6896A's bezel in half. Next, he grabbed the top half of the bezel and cut out the center, including the drive bays, creating a U-shaped frame. Owen filled the gap with a sheet of modder's mesh.

At this point the frame wasn't attached to the front of the chassis. Owen needed a device that would let users remove the cover when they needed to access the drives

and power button. "I went to a woodworker's supply store and I just kind of went through the bins of jewelry box hinges and I bought like five different styles of hinges," says Owen. "And then I just kind of Frankensteined something together." The result: a cover that lifts away from the drives and easily clears the radiator on top of the system.

If you're a fan of race cars, you'll probably recognize the carbon fiber trim that covers the front of the chassis underneath the retractable cover. The material is sturdy but expensive: A single 12- x 12-inch sheet can cost as much as \$50. Finally, Owen installed a Bulgin power button. You can find these stainless steel buttons on boats. Owen put a washer behind the button to make it appear larger. "I used real coarse sandpaper and masked off the center portion of the button, and then I used coarse sandpaper to rough up the trim around the button," Owen says. "And then I used metal-cast anodized red paint, and I painted that red so it'd match the chassis."

Although Owen generally doesn't like sticking emblems onto a case, he couldn't resist when he saw the Corvette C5 1999 emblem. He modified the emblem by removing the metal ring and then gave it a 3D feel by cutting a 1-inch block of pine to match the emblem's outline. He covered the block with carbon fiber vinyl.

Stingray Hood

Owen used his Dremel to cut the center out of the other half of the 6896A's front bezel and then attached the newly created frame to the lower front of our rig so that it surrounded the chrome fan covers.

Next, he started the Stingray hood, which has an intake area near the windshield. This hood, which covers the front panel fan covers, proved to be one of the rig's most complicated and time-consuming mods, but it's also one of the most dramatic. "I wanted to do something based on a Corvette, yet not trying to look like a Corvette, because you can never pull it off on a square box," says Owen. "But styling cues that remind you of a Corvette. Like somebody who's into



Owen placed a motorcycle filter cover over each 120mm fan in the front of the case.

As it turned out, the filler caused its own problems the first time around. “As the filler cured, it curled the plastic base that I had for the hood that I made,” says Owen. “It warped the plastic on one side.”

Owen solved the problem by reapplying the filler and then stacking three paint cans on top of the hood so that it cured with out curling. Next, he sanded the hood with several sandpaper grits, filled small air pockets with putty, and then applied a primer. Three hours later Owen coated the hood with lacquer paint six times.

“I’ll let the ‘Classic Black’ lacquer paint cure for at least one week before wetsanding and buffing out the finish with 3M Perfect It III Rubbing Compound,” Owen says. Whew.

Exhaust Fans

Corvettes: They can see right away by the way the hood is designed, ‘Well that’s just like a Stingray hood.’”

Although Owen generally doesn’t draw diagrams or create models before digging into a mod, he changed tactics when creating the hood by building a template out of cardboard. Owen then cut the appropriate pieces from 22-gauge steel and modder’s mesh and then epoxied them together with Scotch-Weld DP-190 and some clever joint taping.

Of course, the steel hood only vaguely resembled a Stingray hood at this point. The sharp edges contrasted heavily with the Stingray’s soft curves. After letting the hood cure for 48 hours, Owen applied Evercoat Everglass, a short strand fiberglass filler, to the entire hood. He considered using Bondo, but chose the fiberglass filler because he was looking for the strongest material around.

AMS cuts fan grilles for two 80mm fans into the back of the CF-1009, but



With its airbrushed logo, Stingray hood, retractable bay cover, and flaming radiator, our system will surely impress at LAN parties.

Owen didn’t like the boring, restrictive layout. He cut out the fan holes and added the same rubber U-channel edging and noise muting grommets that grace the front panel’s 120mm fans. Next, he created a matching accent plate from aluminum and modder’s mesh, which replaces the original grille. Owen covered the Evercool fans’ stickers with carbon fiber before mounting them.

Radiator

Few components scream power like a watercooling radiator that supports three 120mm fans, but we didn’t buy the Hardware Labs Black Ice XtremeIII Radiator just to show off. We planned to cool an overclocked AMD Athlon 64 FX-57, the mobo’s nForce4 chip, and two 512MB NVIDIA GeForce 6800 Ultra graphics cards.

Owen quickly discovered that the heavyweight radiator wouldn’t fit inside the case, so he created a custom plate that secured the radiator to the top of the chassis via 20 noise-muting rubber grommets. “Ten mounted in the radiator plate and 10 mounted in the top panel,” says Owen. “These grommets support the weight of the radiator, which in turn helps eliminate vibration noise in the top panel.”

Owen selected Evercool EC12025M12B fans, which sit below the top of the chassis, behind the back panel’s 80mm exhaust fans. Finally, he covered the top of the radiator with modder’s mesh and painted the top red. He finished off the paint job by adding some black flames.

Airbrushing

Owen turned to his long-time colleague, Lin Anderson, when he wanted to have the Corvette C5 logo airbrushed onto the side panel. Before Anderson painted the panel, Owen modified a picture of the emblem by taking out a ring that encircled part of the

Tools Of The Trade

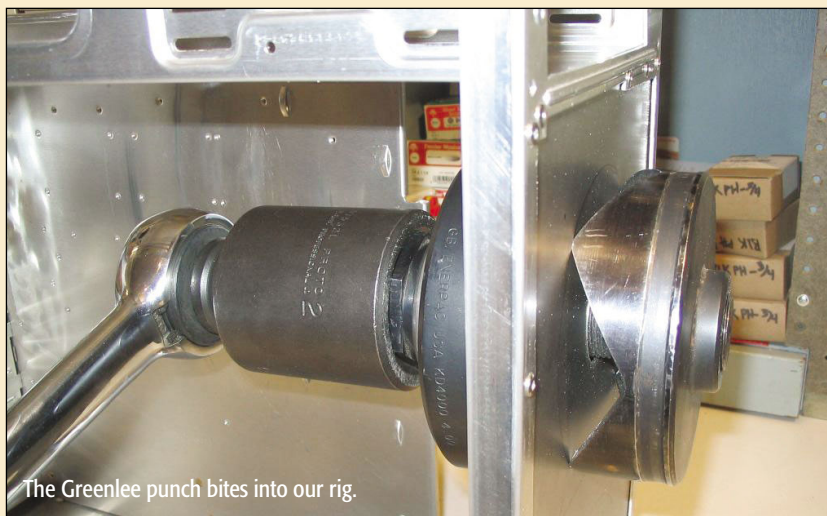
If you've used nibblers and hole saws to cut fan holes into your computer case, you know that both tools produce ragged edges (particularly the nibblers, which often twist the edges, as well). Instead of dedicating a few hours to filing down rough hole edges every time he worked on a case, Owen invested in two tools several years ago that take all the pain out of fan hole modifications.

Owen relies on a Roper Whitney punch to create the fan mounting holes.

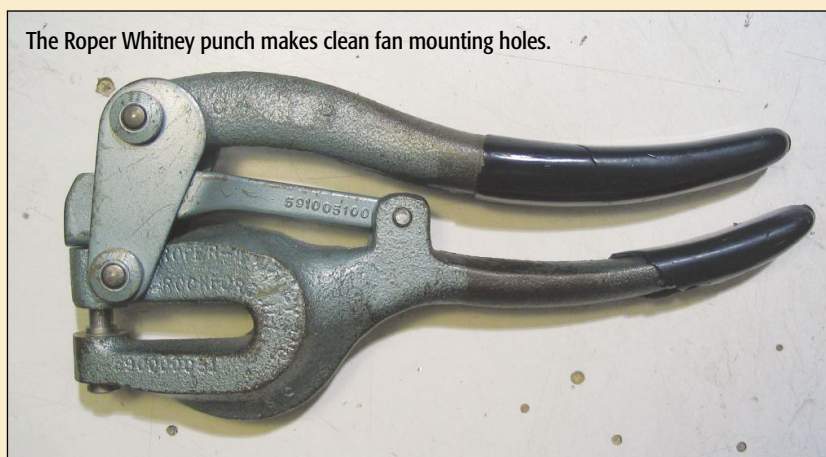
The hand tool isn't cheap at \$52, but it creates clean, screw-size holes. The bigger of the two is the manual Greenlee punch, which includes a circular blade that attaches to a long threaded rod. Once you slip the rod through a small hole (you'll need to drill this hole, but you don't have to worry about rough edges as the blade will remove the area in a few moments), you attach a wrench and then twist it until the blade punctures the panel. Owen recommends using a 19-inch

wrench for leverage. "If you do it with anything shorter, you're just making more work for yourself," he advises.

The punch can't beat hand nibblers when it comes to price (a standard Greenlee punch costs as much as \$300), but Owen feels it's worth the cost. "It almost looks as if it was laser cut. It's a very clean cut. It's a cleaner environment with [the Greenlee punch], and it's a precise cut." ▲



The Greenlee punch bites into our rig.



The Roper Whitney punch makes clean fan mounting holes.

emblem so that it had a cleaner look, and so users wouldn't attribute the mod to a certain year Corvette. (He also removed the ring from the emblem on the front of the rig.) Anderson then worked his magic on the side panel.

Wrapping It Up

Although Owen cooked up some flashy mods, he didn't overlook the details that complete the piece. The case's multitude of fans (six 120mm fans and two 80mm fans in all) create more than a buzz when they run at top speed, so Owen installed a Mitron fan controller—inside the hard drive cage. "I've always liked components that rarely need adjustment to be hidden out of sight," says Owen. "It's out of sight and still easily accessible."

Next, Owen attached the chrome fan covers to the front panel-fans that sit under the Stingray hood. "When I think of a Corvette 427, it has to be the big block 427 Stingray," says Owen. "The first thing you see when you open the hood of a Corvette 427, is the massive chrome air filter cover." Each of the modified Mikuni motorcycle filter covers sits atop a short, mesh tube that lets the intake fans suck air under the covers and into the chassis. Owen finished off the rig by adding custom 6061 billet aluminum trim to the side panels.

Ready For Action

After the dust settled and the paint dried, an entirely new chassis sat on Owen's workbench. No longer an unremarkable box, the Corvette Stingray mod stood tall, oozing muscle car attitude. The Stingray hood adorned the front, the retractable cover opened and closed easily, and the radiator awaited the rest of the watercooling system. When the beast arrived at CPU headquarters, we gawked at it until the photographers whisked it to a photo shoot. Then we loaded it up with some of the hottest components on the market and took our Stingray for a spin. Don't forget to check out "Born To Run" on page 92. **CPU**

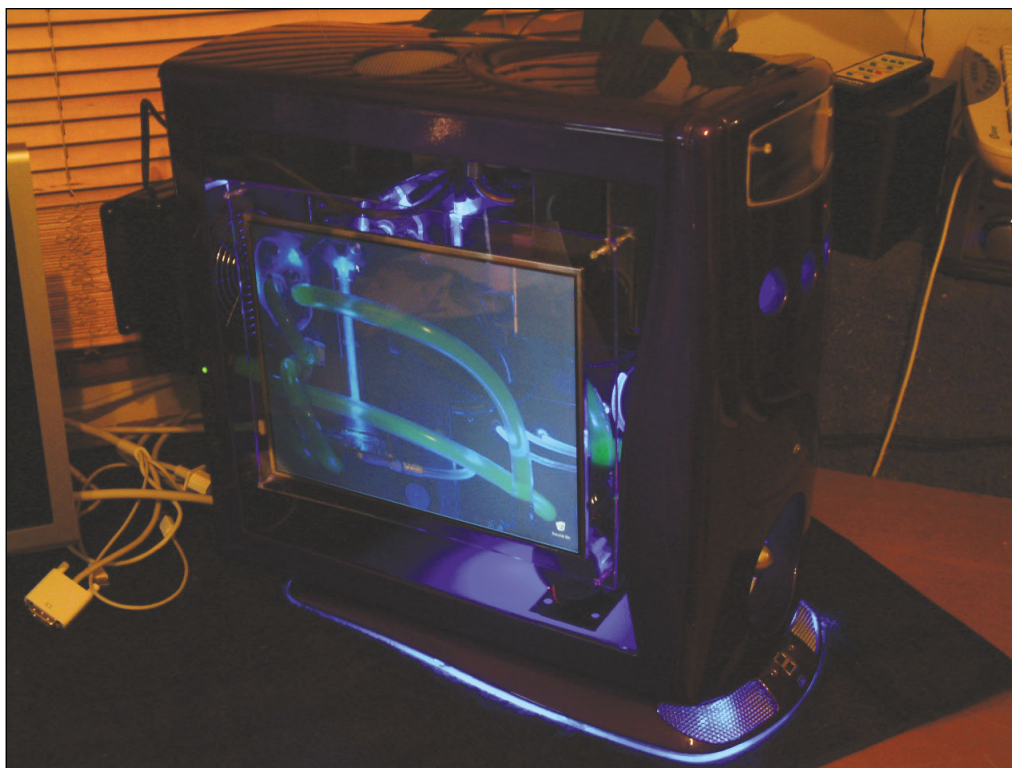
by Joshua Gulick

Mod(ern) Art

Dremel Masters Showcase Their Skills

HP Resurrection II Evolution

Luke St Clair (aka Defyant)



HP Resurrection II Evolution was the second in a trilogy of HP mods I'd set out to build. The first HP mod was a watercooled system, but had minimal external modding. This time I wasn't going to hold back!

I wasn't sure exactly what I was going to do, but I started with a Bondo-grafted and countersunk front 120mm blow hole. Next, I created a custom side LCD mod. I wanted to keep a functional window on the HPRES2, but I also wanted it to have a side-mounted LCD.

Next, I moved onto the base unit. I moved the base forward a few inches so

the front of it stuck out a little. The idea was to give the base two eye-like slots in the corners, which added a nice look to the case. Next, I grafted in the USB and multimedia ports. I added a remote Eject button and speakers behind the meshed eyes, as well. I wanted to add a CD-ROM drive but not lose the sleek look of the front panel, so I made a stealthed CD-ROM cover. I used clear Plexi and shaped it with heat to suit the front.

At this stage, the PC was ready to be painted, so I took it to a friend's spray shop. The case was primed and

wetsanded and then prepped and painted with four coats of purple tinter. The metallic paint looked very rich and deep. I brought the parts home and assembled the case hardware, but I still wasn't happy. The case needed more, and aircooling wasn't enough, so I water-cooled the system.

I made the computer case's reservoirs, and using 50mm tubing, I fabricated a custom bracket system that was bolted to the side of the PC's case. The watercooling system consisted of three new silver prop blocks, a Swiftech mpc650, tubing, and a BIX 120mm rear-mounted radiator.

I also made a motherboard stealth cover. I used hobby plastic to make the cover, which I scored, folded, and cut into shape. The case is currently on display in my home town of Sydney, Australia, and will be doing a circuit of three shops over the next few months. ▲

Tech Specs

Mobo	Gigabyte NF2
CPU	Athlon XP 3200+
RAM	512MB DDR400
Video	Sapphire 9800 Pro
Hard Drive	200GB Western Digital
Other	Custom paint, custom watercooling, LCD mod

“40”

Bruno Ferretti (aka Alonso Bistro)



I started this mod after I found a battery's display rack that made me think, "This is my next mod!" I used the display rack as the basis for my case. The mobo's tray is a piece of orange acrylic. I used another piece of orange acrylic behind the mesh in the front of the case. Next, I made two cuts; the first one is the DVD bezel and the second is a "wink" to the mod's theme, "40," which is itself a wink to my last birthday. I cut the back of the case to make room for the mobo's plugs and an 80mm fan to extract warm air.

The rack was chromed originally, but the chrome was a bit spoiled, so I decided to paint the rack black. The top's handles are furniture accessories with a thin orange-acrylic piece underside, lighted with orange LEDs.

I embellished the front with a piece of aluminum painted black. I placed the hard drive next to the PSU, held in place with acrylic pieces. I made the side door with the same orange acrylic, which is held by two hinges.

For the base I've used an old 17-inch monitor base that's glued to an orange

acrylic piece. I light this acrylic with an ultra-bright orange LED. ▲

Tech Specs

Mobo	ASUS A7V400-MX
CPU	Sempron 2800 +
RAM	PC 3200 512MB x 2
Video	PNY 6600 256MB
Hard Drive	80MB Seagate Barracuda
Optical Drive	LG gdr-8163/b
Other	Qtech 400W

Satan's Deuce

Bonzanego (Bonzai-mods.com)

The Satan's Deuce project began leaking into my sketchbooks about three years ago. I grew up working on old cars. I watched and helped my grandfather and uncles restore and maintain classic cars. My first car was a 1966 Mustang, which I "wrenched on" from age 15. The Deuce is inspired by those experiences and by the styling of 1930s auto design.

The basis for the project is a Lian-Li pc-70. It's a long, tall, and lean case that seemed a natural for the final shape I was aiming for. I sculpted the rounded top of the case and front bezel with foam and

fiberglass. After I smoothed out the front bezel, I made a mold of it and cast a solid urethane copy that would stand up to years of opening and closing. I wanted the interior of the case to remain as stock as possible so it would accept any hardware I wanted to add, including a watercooling setup. The front of the case originally housed two 80mm intake fans. I took those out and added an all-new front intake made from aluminum, which houses a single 120mm fan covered by a custom-made fan grille. I made three upholstered panels for the case. One is on the inside of the case, and the other two are up front.

The paint job is automotive paint that I applied with spraying and airbrushing equipment. I made the flames using five colors

faded from front to back and hand-pin-striped in bright blue. The whole thing is clear coated with four coats of high solids polyurethane made by PPG. I made the case feet from wood and painted them black. The front feet are a bit shorter than the rear, so the case would have a slight rake to it, like the old deuce coupe hotrods. The project has over 250 hours of work and matches my design expectations perfectly. ▲

Tech Specs

Mobo	Chaintech Zenith CT-9cjs
CPU	3.06GHz P4
RAM	512MB PC2700 DDR
Video	ATI Radeon 9600
Hard Drive(s)	100GB Western Digital x2 (RAID 0)
Other	Lite-on 48X CD-RW



Wooden Dualie

Carl and Jeff Vanderlip



What happens when you cross a dual-processor server with a 1930s-style case? You get a Wooden Dualie. We had been thinking about a dual-processor machine on and off for a while.

We realized the Tyan motherboard (S2882D) we bought was huge by current ATX standards at a whopping 12 x 13 inches. Normally this would mean buying a server-style case. Instead, we decided to build a case ourselves. Rather than design it like every other case, we decided to build it in multiple layers.

The lower level houses the Antec power supply, two hard drives, a DVD burner drive, a floppy drive, and a DVD storage drawer. The middle layer carries the motherboard, two Opteron 246's, 512MB (x2) of Corsair ECC-registered memory, and XP-90 heatsinks that cool the CPUs using 92mm fans. The

system's audio and video consist of a Chaintech AV-710 8 sound card installed in a reverse 1U riser and an onboard ATI Rage XL. The motherboard mounts to the tray by way of 3/4-inch diameter standoffs.

To cool the first layer, a 92mm fan blows across the hard drives and an integrated heatsink, and the air is removed by the Antec's fan. On the second layer, a wall of eight 80mm fans in an egg-crate frame blow across the components. Four 1- x 12-inch EL strips illuminate the motherboard layer.

The case is 16.5 inches square and sits 13.5 inches tall. It is made mainly of 1/4-inch oak stock. We made the top, bottom, and motherboard tray of 6-inch strips reinforced with 3/8-inch square stock. The corner posts are 3/4-inch oak dowels. A 1/2-inch square bar joins the dowels on each side and also acts as a stop

for the motherboard tray. The tray slides up and down on two of the dowels.

All cabling connects to the motherboard from below, via holes in the motherboard tray. This keeps the motherboard layer clean and neat. The lower layer has 1/4-inch oak sides. Air flows in and out of the bottom level via two hexagonal patterns of 1/2-inch holes, giving it an old-time radio look. We stained the wood with a mahogany finish and sealed it with a satin urethane varnish. ▲

Tech Specs

Mobo	Tyan S2882D
CPU	Opteron 246 x2
RAM	512MB x2 (Corsair)
Video	ATI Rage XL
Hard Drives	2
Optical Drive	DVD burner
Other	Chaintech AV-710 sound card

RubberMaid LAN Party Rack

Ryan Janssen

I needed a way to move quite a few servers to a LAN party I frequent in Minneapolis. My rack needed to be light, house at least three servers, *and* stay cool. Thus the Rubbermaid LAN Party Rack was born. The system stays incredibly cool, and each

board has its own power supply. I used a 400W power supply at the bottom of the rack to power all the fans and the bottom board. I hooked up the fans to bay busses at the top of the rack to control fan speed.

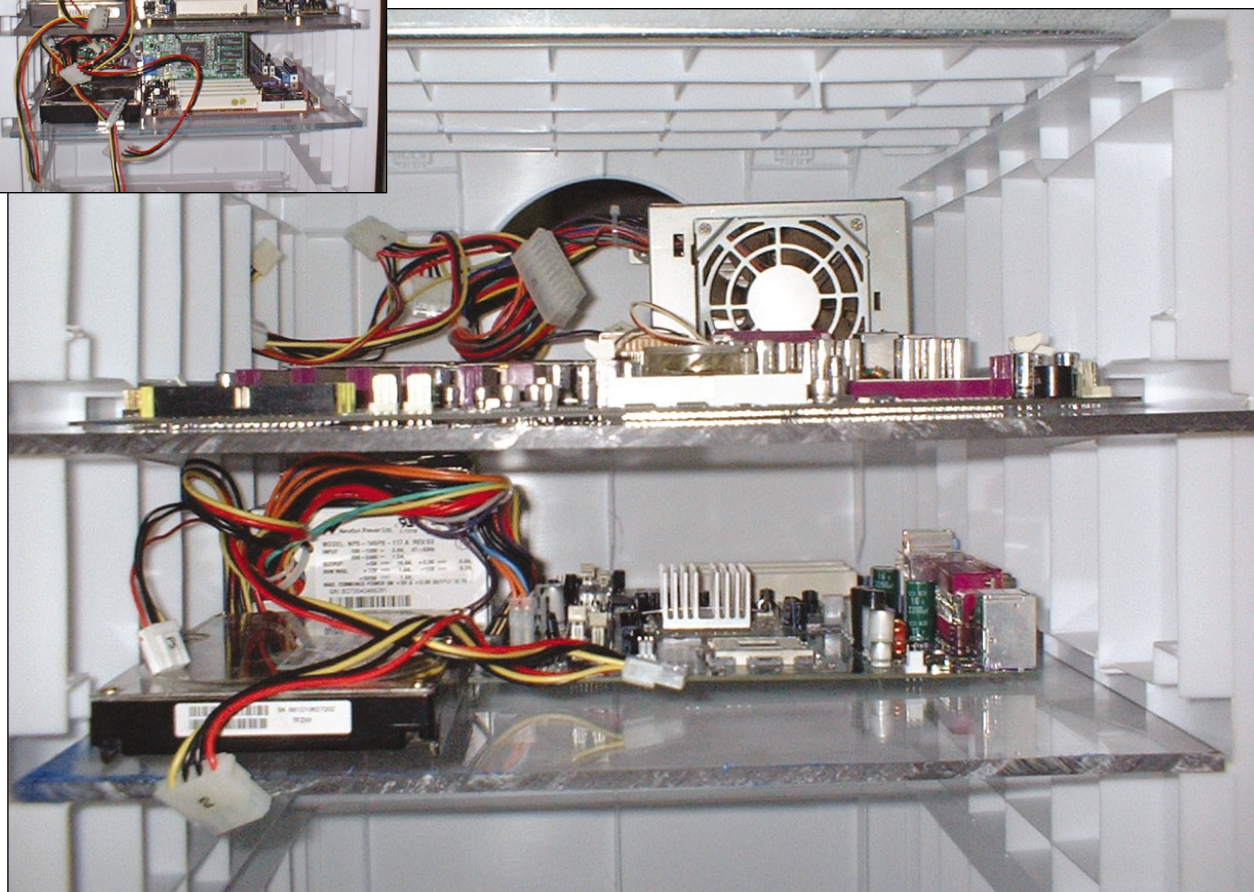
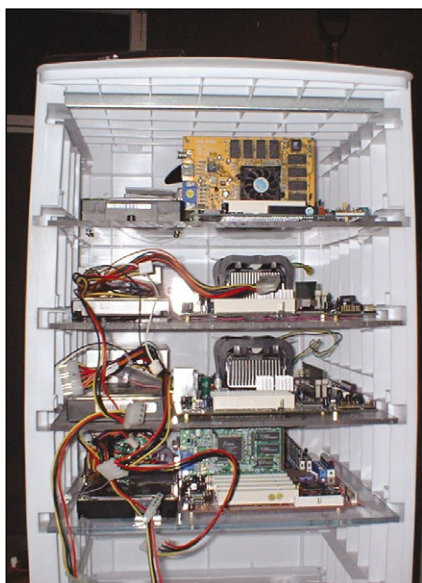
Three of the motherboards on the system use 2.4GHz P4s with 1GB of memory each, and each board runs on an Intel D845GRG motherboard. I also set up two systems using 2.8GHz P4s running 1.5GB of memory on two Abit VT7 mobos. Each system has a 20GB hard drive using Western Digital and Maxtor parts, as well as Ti4200 and Matrox video cards I had laying around.

The four topmost systems run on 110W mini-ATX power supplies that I gutted and mounted to the Lexan acrylic.

For network connectivity I ran a keystone jack out of the bottom of the system. This allowed for quick connection of network cables. The whole unit sat on wheels to make it easier to move around. ▲

Tech Specs

Mobo	Intel D845GRG x3; Abit VT7 x2
CPU	2.4GHz P4 x3 (Intel boards); 2.8GHz P4 x2 (Abit boards)
RAM	1GB per mobo (Intel boards); 1.5GB per mobo (Abit boards)
Video	Various Ti4200/Matrox
Hard Drive(s)	20GB x5 (Western Digital/Maxtor)
Optical Drive	N/A
Other	Various PSUs/fans; one Rubbermaid storage rack



Home Sweet Home

Brian Carter (aka Boddaker)



I wanted to get my mom a computer, but I didn't have any extra cash to buy her a new one. So I took inventory of all my leftover parts, and with a few added pieces from my brother's stash, I was able to come up with a whole system.

When I thought about building a case for it, I thought it would be appropriate to use leftover parts from my various home improvement projects to make a home-themed case. The idea was to make her case look like a part of her house. So I created a sliding cover over the existing metal case. I coated and textured it with drywall compound and dressed the top and bottom edges with molding and trim pieces.

To power up the computer, I used a momentary toggle switch disguised as a wall light switch. I stealthed the CD-ROM drive behind the front-molding piece. The front also features an air intake opening, which houses the floppy drive and also doubles as convenient mouse storage.

I made the top look like hardwood flooring. I used redwood planks, cut them at 45-degree angles, and glued them



Tech Specs

Mobo	SOYO motherboard
CPU	AMD Athlon XP 2200+
RAM	256MB PC2700
Video	GeForce MX2
Hard Drive(s)	40GB Western Digital
Optical Drive(s)	Sony CD-ROM/DVD combo drive
Other	Sound Blaster Live sound card, Logitech cordless keyboard/mouse, Logitech QuickCam

together. I used a household floor register to cover two Zalman 80mm low-profile fans that provide exhaust for the case. I also made a back panel to support a standard outlet, a network wall plug, and a round cable grommet.

For the window, I etched "Home Sweet Home" in a cross-stitched pattern onto a piece of Plexiglass and frosted it to obscure the internals. (Remember, this case is for my mom, who isn't interested in seeing a bunch of circuit boards and wires). To continue the homey theme, I framed the design and, using some wire and a nail, made it look like a wall hanging.

This system has modest components. And because this computer will only be used for email and an occasional game of solitaire, it needn't be watercooled and have bleeding-edge graphics!

When I told my mom about my idea, she liked it so much I decided to go ahead and do it. And I'm glad I did. This case turned out better than I had originally imagined and will look great displayed on her roll-top desk. No one will ever guess it's her computer! ▲

Unreal Sonata

David M. Gingerich (aka TAZTG)



Case modding and computer gaming have been my passion for some time now. I've always been a huge fan of first-person shooters and especially the Unreal Tournament Series (UT, UT2003, and UT2004). Combining these two passions only seemed natural, and thus, the idea for the Unreal Sonata was born.

I had a general idea of what I wanted my Antec Sonata case to look like when I was finished modding it. I wanted to incorporate the different UT logos into the case and use UV Red to light up the interior, which would look great with the Piano Black paint of the case. I had many ideas for the various types of mods I wanted to do.

When asked how much time and money I spent to complete this case, I always say, "I do it for the fun of case modding, and it's worth the time and cost to me." Yes, my wife thinks I am crazy to cut up a perfectly good case, but she understands how much pleasure I get out of case modding. ▲

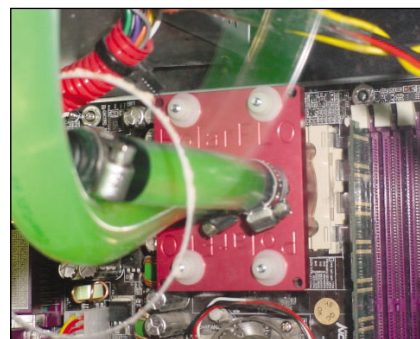
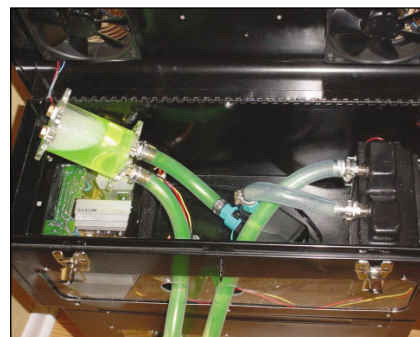
Tech Specs

Mobo	ASUS P4S533
CPU	Intel P4 2.4GHz
RAM	1GB Corsair XMS CMX-2700C2
Video	e-GeForce FX5900Ultra
Hard Drive(s)	40GB Maxtor ATA100 and 160GB Maxtor ATA133
Optical Drive(s)	Lite-On CDRW/DVD Combo (52X32X52X16)
Other	ATA 133 Controller, Audigy 2 Gamer sound card, Antec NeoPower Modular 480W PSU



Water Toolbox

David Swingle (aka JediSpam)



The Water Toolbox mod was my first attempt at watercooling. I was afraid of leaks, so I didn't want all my watercooling components in my case. Also, it's hard to fit a watercooling setup in a midtower case.

I started the Water Toolbox mod with a simple toolbox I bought from Lowes. I cut 120mm blowholes for the heatercore fan and the other cooling fans. I also ran a second power supply in the toolbox to power the fans and lighting within the box. I had never seen anyone put tubing through a computer's window, so I thought it might be a good idea. After cutting all the necessary holes for the toolbox, I realized I had to mount the toolbox to the case or it certainly would tip over. I used four strong bolts and several washers to fasten the toolbox to the case, and I could carry around my computer to and from LAN parties using the toolbox's handle. I enjoyed building the Water Toolbox mod and achieved excellent overclocking on my processor. ▲

Tech Specs

Mobo	Soyo KT 400 Ultra
CPU	AMD Athlon XP 3000+ Barton 333 MHz FSB
RAM	Corsair XMS 1GB (2 x 512MB) DDR 400 (PC 3200)
Video	XFX GeForce FX 5600
Hard Drive(s)	40GB Maxtor 7,200rpm
Optical Drive(s)	Sony CD-RW and DVD Drive
Other	PolarFLO Universal CPU Water Block SF 1/2-inch, D-TEK Pro-120 Hi Performance Radiator (Heatercore), Hydor L30 Water Pump, Criticool WaterPlant Reservoir

Paint Like A Pro

Three Case Studies

With more and more system builders and case manufacturers offering cases and peripherals in an ever-widening range of color choices, it's clear that the days of PC enclosures that "come in any color you want as long as it's beige" are long gone; truly a good thing. But what if you grow tired of your original color choice or worse yet, you still own a boring beige box? Whether you want your computer to stand out in the crowd or are just ready for a change, painting your computer case is one of the best ways to make it happen. I will show three ways to achieve a professional-looking paint job for your case.

I'll use three soon-to-be-modded Compaq DeskPro cases, which in their original state are not very attractive. I'm only painting these cases, not modding them (not that they couldn't use a few mods). Remember, case cutting always comes first, so if you have any windows, designs, or blow-hole cutting to do on the case or side panel, take care of those tasks before painting.

Stripped To The Bone

The first case-painting step is preparation of the surface to be painted. The DeskPro cases are a worst-case scenario, in no small part due to the thick layer of ancient beige paint that is baked on. I decided to use three paint removal techniques, one for each case, with the first being sanding.

I removed stickers from the cases, used Goo-Gone to remove the sticker residue, donned a dust mask, and used a mouse sander to sand the case because it was what I had on hand. If you have a little money to spare, a random orbital sander would definitely make this job easier, but if you are on a shoestring budget, a block sander will do. Using the mouse sander and two sandpaper attachments, I stripped

the first computer's case in just over two and a half hours. Block sanding could take double to triple the time and should only be done as a last resort.

Another case-stripping method will require a \$7.51 can of Sherwin Williams Sher-Strip spray-on chemical stripper. This stuff is all kinds of nasty, so be sure to don a respirator and rubber gloves if you use it. It figures that the easiest way to strip a case also happens to be the most

The last method of paint removal requires a heat gun, a metal scraper, and an Ove glove. Ove gloves are awesome. I picked up a pair on sale for \$11 apiece, and for this method of paint removal, they are indispensable. I held the scraper in my gloved right hand and slowly moved the heat gun (set on high heat) back and forth across the painted surface of the case. I was able to remove the paint quickly using this method. If you try this at home, take care to not try to remove too much paint at once or press the scraper too hard against the case, as the scraper can gouge the metal. Also, don't point the gun too long in one spot; it can cause the paint to goo up rather than scrape off. Keep the gun and scraper moving. I only used the heat gun to strip the bottom of one case, but I



These cases are about to get a major makeover.

hazardous method. The fumes are carcinogenic and toxic, and the vapors can flash ignite. But the Sher-Strip spray is my new preferred way to strip a case due to how quickly and effortlessly the paint comes off using a plastic scraper. One can of stripper is just barely enough to cover a complete case, so either use the spray sparingly or buy two cans. Once I scraped the paint off the case and side panel, I gave them a quick rinse with the hose to remove any chemical residue. I let the case dry completely and then gave it a light scuffing with the mouse sander. The total time to chemically strip the case was just less than an hour.

estimate that an hour and a half would get an entire case done.

Once I stripped the cases to their bare metal, I set them aside and moved onto the plastic pieces for the front. You'll have to completely disassemble the front of the case before you paint it. Remove the power button, drive covers, and any other parts that come off, as well as parts that will not be painted, such as the clear plastic covers for LEDs. Remove any stickers from the front of the case and use Goo-Gone to clean up the residue. Grab the mouse sander, and, using a fine sanding pad, sand the front bezel. You should sand it to the point where the bezel's raised Power, Hard

Drive, and Reset symbols are sanded off. Don't let the mouse sander sit in one area too long. Keep it moving to prevent the plastic from heating up too much and melting. Sand everything, from the textured bay covers to the power button to level everything out. Sanding will also scuff the surface of the plastic, which will make the paint adhere better. Wash the case's front parts, side panel, and case in a mild detergent bath. Be sure to thoroughly wash and rinse each piece and then allow all parts to dry completely.

Once all the case parts were dry, I cleaned them again to remove any residual grease or wax. For this task I used Painters Pride precleaner. I donned a pair of rubber gloves, put some of the precleaner on a shop towel, and gave all the parts a once-over. As an alternative you could also use 99% isopropyl alcohol to preclean your parts.

The Case Is Your Canvas

After you've thoroughly cleaned and dried all the parts, it's time to scout a location to paint. A professional paint booth is the preferred method, but a garage with proper ventilation will suffice. As a last resort, you can assemble a disposable booth using a \$20 canopy and some blue tarps. I was assembling my disposable booth when my neighbor asked me what I was up to, and after I told her, she graciously offered her garage for my painting needs. Needless to say, I accepted. Painting outdoors with nothing to stop the wind, bugs, or dirt is not recommended, of course. Also, always wear a respirator when spraying paint no matter where or how you spray it.

I'm painting two of the DeskPro cases using different techniques (spray can and spray gun), and each technique requires its own tools and materials. Let's start with the spray method.

Using canned spray paint to achieve a professional case-painting result is kind of a mixed bag. It can be done, but this depends upon how you go about it. If you decide to go the spray-can route, you should buy one brand of paint for the entire job. Mixing and matching spray paint products is not recommended, as using different products may lead to hit-and-miss results. You may



Ever seen a case naked?

want to pick up a spray can gun attachment. It's inexpensive, easy to control, and reusable. For my spray can project, I chose Plasti-Kote Brand sandable primer, black enamel paint, and super lacquer. I also bought a tack cloth; 350-grit sandpaper; a foam sanding block; 800-, 1200-, and 1500-grit wet/dry sandpaper; and a can of black vinyl color.

I decided to use black vinyl dye on the bezel, bay covers, and other plastic pieces from one of the Compaq cases. For plastics painting, most modders swear by Krylon Fusion spray paint, but I have found nothing bonds to plastic quite like vinyl dye. Vinyl dye is also very forgiving and dries really fast. You can recoat or handle the pieces after 10 minutes drying time. The only downside to using spray-on vinyl dye is that it does not come in as many colors as spray paints, and it doesn't adhere well to metal at all.

If you decide to use a spray gun rather than spray cans, be prepared to spend a lot more for the necessary tools. I had an air compressor but little else required for painting with a spray gun. I found a nice little 7-ounce gravity feed touch-up spray gun for \$20 and a twin cartridge respirator for \$22 at Harbor Freight. I made a trip to King Automotive and picked up the other paint supplies necessary to accomplish a pro finish: primer, paint, lacquer thinner

clear coat, hardener, filter funnels, stir sticks, measuring cups, and a propellant spray gun, at a total cost of \$110. Now, I was ready to paint.

The spray gun I chose doesn't hold a lot of paint, but you only need about 7 ounces for at least one full coat on a standard sized tower. The gun I bought may be inexpensive and small, but it has the features you should look for in a spray gun. It has an adjustable fan size that you control by turning a screw on the back, so I can choose a wide or narrow spray. I can also adjust the jet shape by turning the air cap (the piece at the tip that resembles a wing nut). When the cap is perpendicular to the ground, it produces a horizontal jet, and when it's parallel, it creates a verticle jet. I can also control the paint flow by turning a volume adjustment screw to increase or decrease the output. The instructions for the spray gun indicate a pressure operating range of between 33 and 50 PSI. Even though my air compressor has built-in controls for pressure adjustment, I bought a \$6.99 inline air pressure regulator and put it between the hose and gun (using teflon tape to seal the threads) for a more exact pressure reading.

A Tale Of Three Cases

I had all the materials I needed to paint both of the DeskPro cases, and I decided



You'll need a lot of stuff to paint a case, whether you use spray cans or a spray gun.

to tackle both jobs at once. The spray can method and spray gun method are pretty similar. In each instance you'll need to apply at least one layer each of a primer coat, a color coat, and then a top coat (usually a layer of clear coat). If you've never painted before, you should try to find an old case to practice on before painting your showcase rig.

I used wires to hang the side panels and main cases in the garage in preparation for priming. I used the spray can primer on the first case. The spray can primer needed no preparation, but I had to mix the spray gun primer with lacquer thinner according to the ratio stated on the thinner's can. I tried to spray the primer coat evenly. Plan to use two coats of primer to thoroughly cover the case. After I applied the primer to both cases and let it cure (which usually takes a few hours), I sanded them using 450-grit sandpaper. When you sand your case, use caution: if you sand through to bare metal, you will have to recoat the area with primer. After sanding the cases and parts with 450-grit sandpaper, I grabbed some 800-grit sandpaper and resanded everything for a smoother finish. Next I went over all the parts with a tack cloth to remove any sanded primer residue.

Clean your paint gun by spraying thinner through it and wiping it down with a disposable shop towel. Do this each time you finish applying a coat to prevent the gun from clogging. Priming, painting,

and sanding creates a lot of dust, so be sure to clean up your work area when you're done to prevent dust from settling back onto your project.

Now it's time to paint. Temperature and humidity play a major role in the quality of a paint job. Ideally, the temperature should be about 70 degrees with 50% or less humidity.

I used the spray can method for my first case and coated the case's parts in black. I picked up the spray gun next and went to work on the second case. I had to mix the hot-rod blueberry pearl paint with thinner and strain it through a funnel into the gun, after which I sprayed it onto the case's parts and surfaces. For both the spray can and spray gun methods, use a steady left-to-right motion. Start spraying just before the can or gun reaches the left side of the surface and stop just after can or gun crosses the right edge of the surface. Spray perpendicular to the object you're painting and keep the spray can or spray gun 8 to 10 inches from the surface. This should result in smooth and even strokes. Each stroke should overlap the previous one by about 50% for even coverage. After the first coat cures, apply a second color

coat and be sure to give special attention to the nooks and crannies in the bezel or face-plates of the case.

As Clear As Can Be

After the paint cured on the two cases I painted, I wiped down all the parts with a tack cloth and thoroughly inspected them. If you notice light spots in any of the parts you painted or if the paint is uneven, paint it again and let it dry completely. Once you are satisfied with the



This case is lookin' good, but wait until we polish it

the paint job and it's had at least a full day to cure, it's time for the clear coat.

I started with the spray can clear coat. The directions for the spray can clear coat I used recommended several thin coats. For the spray gun method, I mixed the

clear coat with hardener according to a ratio stated on the cans and strained it into the gun. I lightly applied one layer of clear coat using the spray gun. After the first coat cured, I added a second coat, which I sprayed on a little thicker. If you apply clear coat using a spray gun, don't lay it on too thick or the clear coat will run. Two to three coats should be plenty, but more coats will give your paint job a deeper gloss. It'll also add thickness to the panel and bezel edges and can hinder reassembly of the case, so keep that in mind. Once everything is clear coated, give it at least a full day to cure.

The next step I took in our case painting projects was to wet sand both cases. I started off with 800-grit sandpaper to remove any raised spots on the parts. Be careful when wet sanding around the case handle (if your case has one) and edges, however. You're more likely to sand through to the primer in these areas. Wipe the case parts with a wet terrycloth towel once in a while to remove sanding residue and also to check your progress. Once I removed all the rough spots, I sanded the case again with 1,200-grit sandpaper and then followed it up with 1,500 grit. Proper wet sanding takes time and deserves close attention. When you're finished the surface should be completely smooth and hazy from sanding.

Now it's time to making everything shine. I bought a \$25 Turtle Wax random orbital polisher, a \$3 pack of terry cloth towels, and a bottle of Meguiar's Mirror Glaze Professional Fine Cut Cleaner. I applied Fine Cut Cleaner to both cases using the polisher and then let them dry and wiped off the parts with a terry cloth towel. Repeat this process until the case is shiny, but be careful not to go overboard or you'll end up removing the clear coat and paint. If you start to notice flat-looking spots in the finish and paint on the pad you used to apply the polish, you have gone too far and cut down to paint.

Both of my cases looked pretty shiny after polishing. The surfaces were reflective and were nearly finished. But both cases still needed a good waxing to bring out their full bling potential.



These three cases are hardly recognizable in their new coats.

Wax On, Wax Off

Waxing a case is just like waxing a car. Apply the wax in small circular motions, let it dry, and then wipe off the haze. A few coats of wax will help to bring out the true reflective quality of your finish. I used microfiber towels and flannel polishing cloths to shine all of the case parts on both cases.

With a little practice, and by following the above steps, you should end up with a highly polished mirror finish on your painted case that you can be proud of. You can create a very shiny and reflective painted surface whether you use a professional spray gun or (to a slightly lesser degree) spray cans. But if you're the DIY type or you don't have the time to paint a case but still want a custom-painted case, you can get one, if you cheat a little. Read on. . . .

When The Case Is Out Of Your Hands

For the third DeskPro case, I made a few phone calls to local bump and paint shops and car customization centers asking for quotes on the cost of painting a computer case. Once they understood what I was asking for, I received estimates ranging from \$50 to \$150 to paint the case. I decided to go with the middle-ground cost of \$100 and took the case to Skinny Kidz Customz (www.SkinnyKidzCustomz.com) for painting. I had them paint the case a 2003 Volkswagon New Beetle green, a super sweet color. It took a little over a week for them to finish the job. (Some shops

claimed they could do it in a day.) The paint job was top notch and had a high-quality finish.

If you decide to take your case to a professional paint shop, make sure that you disassemble all the parts that need to be painted and that you hand over every piece that you want painted. Painting a computer case may be new to them so be sure to have everything ready to go and let them know what you expect up front to avoid problems. One thing the shop guys told me is that I didn't need to strip the case down to bare metal. The existing paint just needed to be sanded smooth before they painted it, and judging from the finished case, that's definitely true.

There you have it, three cases that would originally not have attracted a second glance replaced by three head-turning beauties, and it took nothing more than a little bit of time and a few coats of paint. The cases are now entirely worthy of more modding. Whether you are the hardcore, tool-loving, do-it-yourselfer type; a shoestring modder without much cash; or even someone without time to tackle it; you now have no excuse not to personalize your PC with a professional-quality paint job. One of the three painting methods I've shown you will help you create an awesome-looking custom case. It's up to you to decide which method is best for you.

Happy modding. **CPU**

by Troy Fryfogle

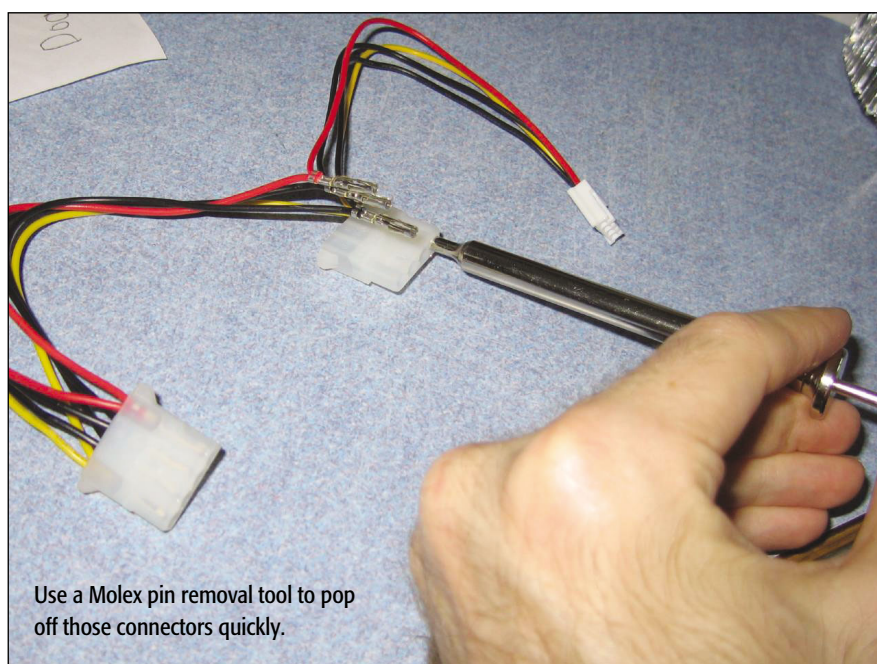
The Mod Shop

Spice Up Your PC With A Few Aesthetic Mods

Aesthetic Mods Q&A

As cool-looking PC cases slowly move from the domain of hardware hackers to mainstream computer users, anyone can run to a local tech mega-mart and buy a

drive, for example), firm inward pressure on the connector's pins pops them backwards out of the connector. A Molex pin remover (a syringe-like gadget that pops pins out) is the quickest and easiest way. You can remove the floppy drive power



Use a Molex pin removal tool to pop off those connectors quickly.

so-called “pre-modded” case. But those cookie-cutter cases aren’t unique and they deprive their owners of the joy of hacking the hardware themselves. Aesthetic case mods don’t have to be difficult. Here are some ideas on how to make your case aesthetically pleasing and uniquely yours.

Q How do I replace the Molex connectors on my PSU?

A There’s no need to be stuck with boring, white Molex connectors; replacements are available in a variety of colors. The trick is knowing how to get the old connectors off. For the larger connectors (the ones you’d plug into a hard

plug by pressing a thin object firmly into the slats in the top of the plug. (If you’ll be sleeving the power supply cables, do it now, before putting the new Molex plugs on.) Simply slide the pins into the new Molex connector, being absolutely sure to get the wires in the right positions.

Q How do I wrap my power supply cables in heat-shrink tubing before I sleeve them?

A “Sleeving” your power supply cables (covering them with tubing) takes care and patience. To do it right, remove the PSU case and free the cables from the exit hole. Remove the Molex connectors from one cable.

Measure the innermost section of cable (from the PSU to the first connector) and cut a length of heat-shrink tubing to match. Slide it over the cables to cover that spot. After you’ve covered each section of the cable with tubing (with the pins exposed), apply heat to shrink the tubing. Now you can sleeve the cables in the same way, by cutting and sliding the sleeving over the heat-shrink, working from the PSU out. Reattach the Molex plugs and move on to the next cable.

Q How do I replace the stock cover of my PSU with a custom cover?

A The coolness-to-effort ratio of this mod is high; replacing a PSU cover is deceptively easy and looks great combined with a case window. You can get custom covers, in acrylic and other materials, from online mod supply stores for \$10 or less. Unplug the power supply and, to be safe, wait a day for the capacitors to discharge before you open it. Remove the PSU from the case, unscrew and remove the PSU’s U-shaped lid, and simply put the new one on. An acrylic replacement cover probably won’t use screws; mine included double-sided tape. The trickiest part can be reinstalling the PSU: An acrylic cover will make the PSU about 1/8-inch taller and 1/4-inch wider. So make sure there’s a little wiggle room in the case before you commit to this one.

Q Can I replace the stock LEDs in my PC case?

A Yes. The difficult part is getting access to those LEDs. On many PC cases, reaching the LEDs means puzzling out how to remove the front bezel and then removing the old LEDs, which may be glued in and soldered to the case. LEDs aren’t meant to be replaced, so case manufacturers don’t always make it easy to remove them (and there’s no way to tell what’s involved in your case until you look). Once you get access to an LED, there’s no need to desolder: Just snip the wires near the diode.



Check out this stock power supply and the same PSU with a clear acrylic cover. Which would you prefer?

Now you can replace it with any LED that accepts 3.3V DC. A soldering iron and hot glue gun may be necessary. Be sure to get the LED's polarity right: The longer lead is the positive one.

Q I just got a cool case badge that I want to stick on my case. How do I backlight it with an LED?

A The easiest way to do it, although not the cheapest, is to buy a case badge light kit from a mod supply store. I got one from FrozenCPU.com for \$15. You could probably gather the parts yourself for less. The kit includes an LED mounted on a 1-inch square piece of plastic. Remove the front bezel and drill a 5/8-inch hole in the spot the badge will go. File off any rough edges and insert the light through the hole. Adhesive on the back of the plastic affixes the plastic square to the case. The kit includes a standard power connector. Plug one end into a free PSU power plug and the other into the LED. Voila, let there be light.

Q How can I make a custom fan grille?

A You can make a fan grille out of almost any material, such as Plexiglas, aluminum, or even

wood. The best way to cut acrylic or metal is with laser cutting, but that can be expensive. Hex mesh or modder's mesh, a flexible metal screen, is a popular option because it is versatile and looks cool. Nick Curtiss, owner of CrazyPC.com, says, "Hex mesh can be formed into any shape you want, basically. You can sandwich it between the fan and the housing. Or, you can cut it to form it to the fan itself, like wrapping paper around a present."

Q How do I install an info display in a drive slot?

A An LCD or VFD (Vacuum Fluorescent Display) screen, small enough to mount in a drive bay, can provide a supplemental display area to show PC stats or personal messages. Displays are available from Matrix Orbital (www.matrixorbital.com), Crystalfontz (www.crystalfontz.com), and other manufacturers. Before you buy, make sure you have enough drive bay space because displays can use the space of one or two CD-ROM drives. It's easiest to order a ready-made bezel from the manufacturer to fit in the bay. Installing the display in the bay is as easy as installing a CD-ROM drive. The display will connect to the PC's USB or serial port. If you get a

serial display, you'll also need to connect it to the PC's internal power, usually 5V.

Q Now that I've installed the LCD/VFD, what can I do with this thing?

A A number of programs for Windows and Linux can put all sorts of interesting info on your LCD. LCDC (lcdc.planetdps.com) can display internal temperatures, voltages, and fan speeds, show the current WinAmp tune, and scroll headlines from RSS feeds, among other tricks. LCD Driver Daemon (www.2morrow.com/lcdd/) shows graphs of CPU load, memory usage, uptime, and free disk space. Other drivers are available from lcdproc.omnipotent.net, www.geocities.com/special_4k4/lcdapplications.htm, and www.mv.net/ipusers/cdwalker/lpt_driver.html.

Q I want to use a UV dye in my watercooling setup. Will that interfere with my PC's coolant?

A The dye won't affect the coolant's ability to cool, but getting the color right can be tricky if your water coolant is already colored. A hue that looks good under ultraviolet light may not look so nice under white light. Many coolants are an UV-reactive green, a holdover from their use by car mechanics. "You can bend the color one way or another by putting dye in it. We can get the UV greens to turn blue with enough blue dye. But in regular light it turns a brownish color which isn't very attractive," Curtiss says. To create your own color from scratch, Curtiss recommends starting with an ethylene-glycol-based coolant that's not pre-colored. "It can be a little hard to find though," he says. He also recommends liquid dye over powder; the powder can settle at the bottom of the pipes and leave a coating that can gum up the works. **CPU**

by Kevin Savetz

The Life

As In Risking Ours, For Science

PC nut sites used to be about thermal paste and cooling. Next came premocked cases and casino bling. Today, you'll find beanies, Red Bull, and caffeinated soap (www.xoxide.com/noname16.html).

Caffeinated soap? Yeah, and a whole lot more: carry straps for your LAN party PC, wireless lockdown dongles, and breath mints that will keep you up all night. Like any other hobby or sport, enthusiast computing has spawned a cottage industry catering to The Life.

Durable Goods

Gaming is only one facet of the geek community, but it's responsible for a lot of the stuff on the back pages of FrozenCPU.com and ADPMods.com.

Razer Diamondback RZ-1600 Precision Gaming Mouse

\$45 at www.newegg.com

If you're a gamer, a crap optical mouse will make you angry. You'll swear at it. You'll try to break it.

Skip the stress with a gaming mouse. The Diamondback RZ-1600 is a 1,600-dpi unit, meaning that it's several times more sensitive to motion than first-gen optical mice. When you twitch the mouse quickly to one side, your character will actually be looking in the direction you intended. We whirled and jumped around like an idiot in Doom 3, and the Razer's tracking was flawless.

Just as importantly, the glide pads are nice and slick. All the usual buttons are present, and the main two have a nice, crisp action. The scroll wheel is lighted and dented, but takes a little more effort to spin than we prefer.

Unlike Logitech's gaming mice, the Diamondback is ambidextrous. It's bit

flatter than that company's MX518, and your thumb fits under an overhang rather than in a little hollow on the side. We do wish the Razer had the Logitech's ability to quickly switch to 800dpi or 400dpi, though.

Our RZ-1600 was Chameleon Green. Its metallic, dark-green finish changed color with our viewing angle, highlighted with purple and blue auras. In short, the Diamondback looks as good as it works.

Thermaltake Gamma Pad

\$19.99 at www.frozenscpu.com

The Gamma Pad is model number A2256 in Thermaltake's catalog. Its finely grained PVC mousing surface worked like a dream with our Razer mouse. Its base, visible around the outer edges, is made of clear, bubbly acrylic. The cool part is that the base lights up, getting its power from a USB port. You can push a button to select the color. Keep pressing it for a hypnotic mode that cycles through all seven colors.

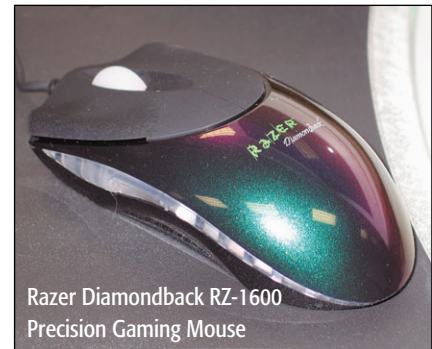
If your motherboard's USB ports retain power when your PC shuts down, as ours did, your Gamma Pad will stay lit. You can push its single control button to shut it off, but you'll have to push it repeatedly to return to the color you want the next time you turn it on. We'd like a Gamma Pad that can remember the last color it displayed.

GearGrip Medium LCD Shield Harness

\$44.99 at www.frozenscpu.com

Once you've brought home that big ol' TFT with the whip-crackin' pixel response time, you're going to want to show it off. But if you drop it or impale it in transit, you'll go from cool to fool in no time.

Get a grip with a GearGrip. The company's well-made medium LCD Shield Harness fit our 18- x 14-inch display just fine. This padded carrying case snaps on



Razer Diamondback RZ-1600
Precision Gaming Mouse



Thermaltake Gamma Pad



GearGrip
Medium LCD
Shield
Harness

and off in seconds. There's an extra Velcro strap for your cords, plus a tough webbing pocket for the AC adapter.

More importantly, there's a panel of ABS sandwiched into one side that protects the screen from table corners and door knobs. Think of it as body armor for your display. If anything hits hard enough to poke through it, the impact probably would've killed your monitor anyway.

Turtle Beach Ear Force HPA

\$99.95 at www.turtlebeach.com

Some games truly are more survivable with surround sound. When you're scanning the enemy from the fringes of the

jungle in *Far Cry* or trying to hide from Manhacks in *Half-Life 2*, you want to know if someone or something is sneaking up behind you. Trouble is, even if you wanted to bring your 5.1 speakers to a LAN party, you wouldn't want some dork in a Punisher shirt tripping over your wires.

Turtle Beach's Ear Force HPAs are real 5.1-compatible headphones, not ones that fake surround sound with algorithms. They have actual front and rear speakers



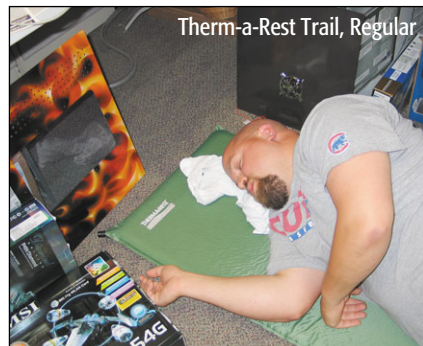
Turtle Beach Ear Force HPA



ThermalTake Xpeaker Professional Music Kit



Wireless PC Lock



Therm-a-Rest Trail, Regular

in the earcups, flanking the center drivers and subwoofers. There are four 1/8-inch stereo plugs coming from the inline volume control module for center/sub, front left/right, and so on. The module gets its power from a wall wart; there's no provision for batteries here.

Unfortunately, the self-adjusting Ear Forces aren't the most comfortable headphones we've ever worn. The cushions aren't thick enough to fully seal out the environment, and the hard speaker panel pressed uncomfortably against our ears.

Still, walking through the intro level of *Doom 3*, we were able to tell where we were in relation to other characters with our eyes closed. Now that's cool.

ThermalTake Xpeaker Professional Music Kit

\$45 at www.frozenscpu.com

Er, "professional" gives the wrong impression here. ThermalTake's A1875 is a LAN party accessory through and through. Why lug stringy headphones or satellite speakers around when you can install speakers right in a drive bay?

Two dinky FCE 2-watt drivers sit in the front panel, backed up by steel resonance chambers isolated from the chassis by rubber and foam strips. There wasn't any buzzing or vibration in our model. The stereo amplifier will distort long before the volume knob tops out, but with enough signal behind it, the Xpeaker can get reasonably loud in a small room.

Sure, the Xspeakers don't sound like a million bucks, but that's not the point. They're convenient and better than nothing. Just like when you hear a good song on AM radio, your ears will adjust to the low-fi audio sooner than you'd care to admit. The Sonix sound chip does a passable job in this context. It's not like Trent Reznor songs need crystal-clear reproduction anyway.

Wireless PC Lock

\$29.99 at www.frozenscpu.com/lap-12.html

This unbranded wireless security system is supposed to lock down your PC when you step away for a moment. Rather than replace thorough security procedures, it's designed more to discourage your buddy

from changing your game avatar's name to SonOfAMotherlessGoat while you're off having a slash.

After you install the software and insert the USB key, a battery-powered key fob communicates with the latter to keep your PC usable. If you walk away, your PC locks down until you come back. You can unlock it by bringing the fob near the USB key or by typing in a password.

At least, that's the theory. Ours hung during installation. No problem; we just consulted the Web site for tech support . . . oh, wait, there was no URL. We finally moved the USB key to another port, and the installation completed.

However, the system sometimes locked us out for no reason. And it occasionally left our PC unlocked even when we threw the fob across the room. Boooooooo.

Therm-a-Rest Trail, Regular

\$49.95 at www.amazon.com

Rest is a weapon, as spy novel assassin Jason Bourne would say. When your Bawls buzz turns into bleary-eyed burnout in the wee hours, lock down your fragbook and stretch out on this. For portable naptime, or even just a soft place to sit and mellow out for a while, not much beats a Therm-a-Rest self-inflating pad.

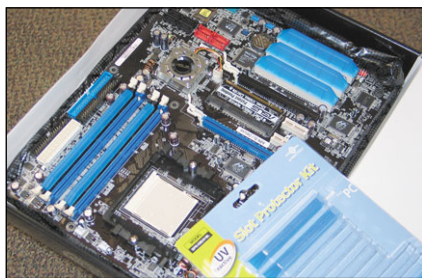
Unscrew the vent cap, wait for the mattress to unroll and inflate itself, and then tighten the cap once more. When you're ready to split, open the vent and roll the pad up. Mountaineers and bushwhackers already know that a Therm-a-Rest is compact and lightweight when deflated. Come to think of it, those qualities are high on LAN gamers' lists, too.

Vantec Slot Protector Kit

\$6.75 at www.adpmods.com

It's a shame how much dust can accumulate in your PC, filtered fans or no. Some of that dust comes to rest in the RAM, PCI, and PCI Express slots, too. If you've ever had a sound card or DIMM that acted wiggly until you removed and reseated it, contaminants between the card's and slot's electrical contacts might have been part of the problem.

Slot protectors such as these can help keep dirt and grit out. Ours were blue and



Vantec Slot Protector Kit

UV-reactive. If you're saving up for an Audigy 4 Pro or second matched pair of Corsair sticks, you can be sure that they'll have clean slots when you install them.

OK, we give up. There's very little reason to drop seven bucks on slot protectors unless you like their looks. If you've color-coordinated everything else in your windowed LAN rig, you can hide the utilitarian earth tones of your unused slots with these.

Foodstuffs

To test these "energy" products, we drank/ate/snorted/huffed them first thing in the morning instead of our usual tea or coffee. Some of their labels promised us vaguely Asian-sounding substances whose names grace the displays on convenience-store counters everywhere. We wanted to experience the borderline-illegal additives that cause otherwise healthy people to mouth gibberish words such as "woot," "leet," and "haxor." The effects were subjective, so we enlisted two deputy tasters to help us describe the experience.

For our Uncontrollable Jitter Factor, the scale is 1 to 10, with a normal cup of coffee at about 4 or 5. Think of a 1 as an Elliott Smith or Nick Drake song; 10 might be Screeching Weasel or System Of A Down. We found that the UJF wasn't strictly a function of caffeine content, especially in the presence of other energy-enhancing substances such as taurine and ginseng. Also, the jitters seemed to hit faster with concentrated products, such as Red Bull and Foosh mints, as opposed to Jolt Red or Bawls Guarana.

Red Bull

www.redbull.com

\$3.65 at www.adpmods.com

Packaging Claim: "Vitalizes body and mind"

Uncontrollable Jitter Factor (1-10): 7

Deputy Taster #1: "Pre-Red Bull: I am but a sleepy desk jockey. Post-Red Bull: I'm Batman."

Deputy Taster #2: "Roused me from my grogginess but tastes like liquid sugar. Better when it has a Stolichnaya aftertaste."

Austrian import Red Bullock is expensive enough in stores (\$7.49/4-pack), but you'll pay through the nose (ring) if you get lazy and pay \$3.65 a can from the first online store you visit. Like, erm, some writers we could mention.

We admit that we had been looking for an excuse to try this energy drink. We'd seen it everywhere in its distinctive, skinny cans. To disguise it from our taste testers, we relabeled their cans Red Steer and Red Heifer.

With 80mg of caffeine per 8.5-ounce can, Red Bovine has the densest caffeine matrix of the beverages we tested. As such, it can hit you between the eyes with the boost you need without making you feel like hitting the head when the gibs start flying.

The taste is like the old soda pop Champagne Brus, of which the closest analogue today would be Cherry 7Up. That's not to say that Red Bessie tastes like Cherry 7Up—it's more tart, among other things—but they both trigger that old, steel-canned Champagne Brus scent/taste sensation along the edges of our tongue. Plus Gatorade. Plus Pop Rocks.

Bawls Guarana

www.bawls.com

\$1.99 at www.frozenscpu.com

Packaging Claim: "Fueled by Bawls"

Uncontrollable Jitter Factor (1-10): 3

Deputy Taster #1: "A pretty blue bottle doesn't make up for the sickening sweetness. Like a beautiful liar. Avoid at all costs."

Deputy Taster #2: "Obvious innuendos aside, this guarana stuff is delectably quaffable. I went from a.m. narcolepsy to full-on insomnia after half a bottle. My fingertips were doing the samba by the time I finished the rest."

Bawls comes in a pretty blue glass bottle. It's studded, presumably to keep it from slipping out of your sweaty paw, but perhaps also to enhance the sensitivity of your mousing hand.

There's about 66.7mg of caffeine in a 10-ounce bottle, which is about halfway between a 12-ounce Mountain Dew and an 8.5-ounce Red Bull. Our buzz after one bottle was pretty mellow. Two bottles should put you in the same orbit as a cup of high-octane java.

Bawls tastes like caramel. There's an unfamiliar fruity taste, too, which we presume is the guarana, a berry from the Amazonian rainforest. The weak carbonation and the funneling effect of the short-neck bottle make Bawls easy to chug, should you feel like it. So there's that.

Jolt Red

www.joltcola.com

\$2 at www.frozenscpu.com

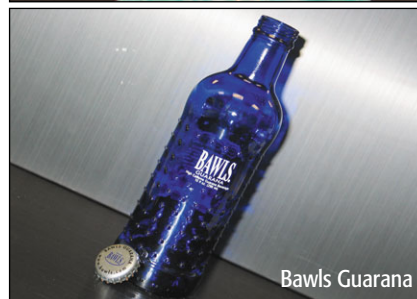
Packaging Claim: "Caffeine x Two"

Uncontrollable Jitter Factor (1-10): 5

Deputy Taster #1: "The snazzy graphics and the skyscraping led me to believe that Jolt would cause my heart to instantly explode. Disappointingly, I was wrong."



Red Bull



Bawls Guarana



Jolt Red



Revenge Pro
Tropical Mango



Buzz Bites



Foosh Energy Mints

Deputy Taster #2: “Quite palatable; tastes like carbonated Hawaiian Punch. Unfortunately, it’s only slightly more potent than Hawaiian Punch. I recommend painting the can black and walking into a bank for a better adrenaline rush.”

Hands down, the coolest decanter in this bunch belongs to the titanic (23.5-ounce) Jolt Red and its stablemates (Jolt Blue, Jolt Cherry Bomb, Jolt Cola, Jolt Ultra, and little Jimmy). The thing looks like a nerve gas canister or new-jack grenade in a sci-fi flick. No, we take that back. It looks like a battery, complete with “+” and “-” signs.

The moment you crack open the sturdy, resealable aluminum cap on this wide-mouth canister, you’ll be rewarded with a “kup-hisssss” like an airlock opening. Let the grin begin. Even cooler is the temperature-sensitive “Power Remaining” strip running down the side of the can, like the ones you’ll find on Duracells.

Jolt Red has a tasty, nondenominational fruit punch flavor with some fizz to it. We felt a slow rush begin about 15 minutes into our can. This matured into a

sustained buzz that produced occasional finger and thumb tremors and only tapered off after we drained the dregs.

A Jolt Red gives you something to sip for an hour or so while maintaining a manageable level of stimulation. For reference, it’s like chugging three Mountain Dew Code Reds.

Revenge Pro Tropical Mango

www.champion-nutrition.com

\$39.99 at www.frozenscpu.com

Packaging Claim (read in pro wrassler voice): “Hydration Rocket Fuel For The Serious Endurance Athlete”

Uncontrollable Jitter Factor (1-10): 3

Deputy Taster #1: “After 40 minutes I realized the only buzz I was getting was from the coconut rum that went so well with the delicious tropical mango flavor.”

Deputy Taster #2: “Looks like Tang; smells like Tang; tastes like Tang. Unfortunately, this powdery surprise was about as potent as Tang for me. It woke me up long enough to coherently throw together a pot of Folgers.”

Revenge Pro is one of those drink mixes that come in a big plastic tub, have an 18,000-word label packed with chemistry terms, and prey on the insecurities of weightlifters. After shaking up and drinking a pint of the foamy, orange stuff, we remembered that weightlifters habitually force themselves to do unpleasant things, rep after rep.

There’s little caffeine in Revenge Pro. It does have additives that increase your blood flow volume, and thus oxygen intake, including coenzyme Q10, feverfew, and omega-3 fatty acids. Guarana and B vitamins make cameos, too. The net effect is a flushed, expectant feeling, as if you’re about to ask someone out or give a eulogy.

Revenge Pro has time-release granules, which translates into Metamucil-like grit at the bottom of your glass. It tastes like one of your aunts took a jug of McDonald’s orange drink and turned it into that foamy, bizarre punch served at wedding receptions everywhere.

Revenge Pro is supposed to help athletes maintain their energy through workouts. Mousing and tapping buttons don’t count.

Buzz Bites

www.vroomfoods.com

\$5.29 at www.adpmods.com

Packaging Claim: “Seriously Caffeinated”

Uncontrollable Jitter Factor (1-10): 2 chews = 8

Deputy Taster #1: “Yummy. But food-based caffeine means stomach contents can cause buzz blockage. I feel a little zippy, but sadly, not zapped.”

Deputy Taster #2: “Strange off-chocolaty taste. Edible, but not delicious. It seems about as strong as they claim it is, but boy do I feel loopy. I was two or three more away from fashioning an aluminum foil cap and spouting doomsday prophecies.”

Ugh. Buzz Bites may taste a little like chocolate at first, but Hershey’s they ain’t. There’s a bitter aftertaste that swells and evolves on the palate, like that time you ate a handful of baker’s chocolate in your mom’s cupboard and, finding nothing to wash it down with, grabbed a bottle of lime juice by mistake.

These “chocolate energy chews” come six to a tin. Each wrapped square—about the size of a Starburst—packs a wallop of 100mg of caffeine. There’s also taurine, ginseng, B6, B12, and some other nutrients.

A couple of Buzz Bites reminded us of a night long ago when a med student friend introduced us to the bronchodilators available at a local truck stop. Soon, we were hearing a small concert in our head, in which They Might Be Giants were singing, “It’s kickin’ in, yeah. It’s kickin’ in, yeah.” As we typed this, one knee bounced up and down like Lindsay Lohan jogging. Do not wolf a whole tin of these at once.

The verdict: disgusting . . . but very, very potent.

Foosh Energy Mints

www.vroomfoods.com

\$5.29 at www.adpmods.com

Packaging Claim: “More Than A Quick Burst Of Fun!”

Uncontrollable Jitter Factor (1-10): 2 mints = 8; 4 mints = 13.7

Deputy Taster #1: “I’m fairly certain that these are holy mints. Because after I ate two of them, the first word I thought was, ‘Holy.’”

Deputy Taster #2: “Tastes like Tic-Tacs on crack. My blood started to itch after I finished the third mint. Who needs epinephrine when you have this stuff?”

For about the same buzz as Buzz Bites, but in a much tastier form, check out Foosh mints. There’s all the caffeine, ginseng, taurine, and B vitamins you’re looking for, without the gagging. Plus they make your breath minty.

Super-size a Cert, and you’ll get a handle on what Foosh are like. Big, fat, white mints with green speckles and, no doubt, a glistening drop of Retsyn! Stamped into one side is “FOOSH”; on the other, the universal symbol for atomic power. That little detail isn’t particularly comforting when it’s on something you’re about to pop into your mouth.

Foosh mints come 12 to a tin. Unlike with Buzz Bites, those foul things, it’s easy to get into the habit of popping another Foosh as soon as the last one dissolves. But be warned: Deputy Taster #2 ate all four of his in about half an hour and reported strange goings-on in his chest cavity afterward. Actually, after three in a row, we started to regret our haste, too.

We wonder whether we should have warned our testers that each Foosh mint is like 1.2 cans of Red Bull? Ah, well.

Lotte Black Black Gum

www.lotte.co.jp/english/index.html

\$1.99 at www.frozenscpu.com

Packaging Claim (Tie): “Hi-Technical Excellent Taste And Flavor” and “Yes, Chewing!”

Uncontrollable Jitter Factor (1-10): 1 stick = 2.5; 3 sticks = 4

Deputy Taster #1: “My nose warned me that this stuff was bad news, so I gave it to a stray dog instead. He wagged his tail and begged for a cigarette.”

Deputy Taster #2: “After a 10-second explosion of minty flavor, it tasted like, well, gum. It was about as potent, too.”

Uter, the exchange student on “The Simpsons,” once offered erstwhile pariah Bart some mysterious European candy labeled “Joy Joy! Mit iodine!” We flash to that whenever we look at our pack of Black Black gum.

Entering its 22nd year, Black Black comes in packages of nine sticks. Not five sticks, not 10, but nine. Instead of looking black, though, it’s a unappetizing dull grey.

Conditioned by decades of American Marketing Know-How, we expected Black Black to taste like black licorice. Thankfully, it doesn’t. It’s more of a strong, minty, Foosh kind of flavor that quickly dissipates. What it leaves behind is a mild mood elevation from an unspecified dose of caffeine.



Lotte Black Black Gum



Penguin Cinnamon Caffeinated Mints

A Google translation of the Japanese Web page puts it: “Refreshing impression rise! Sleepiness clear! Black black!” Well, maybe after nine sticks.

Penguin Cinnamon Caffeinated Mints

www.peppermints.com

\$4.95 at www.adpmods.com

Packaging Claim: “Hatched in Seattle”

Uncontrollable Jitter Factor (1-10): 3 mints = 1; 6 mints = 3

Deputy Taster #1: “Tastes like Big Red gum but with a kick. Not a vicious karate kick to the solar plexus, though. More like a sneaker-coated-baby-foot kick to the teeth.”

Deputy Taster #2: “I like a good caffeine-induced buzz as much as the next guy, but there are some unholy things I will never ingest. Cinnamon-flavored foodstuffs are one of those things. I’d rather pass out midsentence than ea . . . ZZZzzz . . .”

We’re not cinnamon fans. Throwing some our way after two weeks of cage-rattling energy drinks and candies caused a minor rebellion.

Actually, Penguin cinnamons aren’t too shabby. We worried about a flavor wave about as subtle as a Trey Parker and Matt Stone movie, or such a surfeit of cinnamon oil that we’d immediately develop a rash around our mouth that looked like Bozo the Clown’s makeup. But nothing untoward happened.

Nor did a buzz. Six mints should’ve put us well past a Red Bull or even Vivarin high. In reality, all the Penguins did was keep us awake with fresh breath. Which is ahead of the game, we suppose. **CPU**

by Marty Sems

Dew Me!

Coffee is the standard by which other caffeinated products are judged, but various brews and Starbucks-style large servings can make the caffeine content vary from about 80mg to 240mg. For our purposes, we settled on a 100mg figure for a typical 8-ounce mug of your average brew. Vivarin still reigns as the quickest route to scary cardiovascular behavior, but in this motley lineup, Mountain Dew comes off looking meek and timid. (Sources: Vivarin.com, MaxwellHouse.com, MountainDew.com)

Caffeine (mg)		Caffeine (mg)	
Cup of coffee (regular, 8oz)	~100	Revenge Pro (16oz)	30
Vivarin (1 tablet)	200	Buzz Bites (1 chew)	100
Mountain Dew (12oz)	55.5	Foosh Energy Mints (1 mint)	100
Red Bull (8.5oz)	80	Black Black gum	indeterminate
Bawls Guarana (10oz)	66.7	Penguin Red Cinnamons (1 mint)	~15
Jolt Red (23.5oz)	141		

Control Freaks

Panels & Switches For Your Modding Delight

With so many modding products on the market, it's easy to go overboard and leave your modified PC bristling with bunches of disjointed components and their associated power switches. Don't leave your PC's setup messy and convoluted. Instead, invest a little extra cash in control panels, switches, and other goods that will streamline component operation and make your PC easier on the eyes, too.

You already know that PC parts makers offer a plethora of products to please knob twiddlers and compulsive button pushers. We'll give you more insights on the kinds of products you'll find online and offer some insights on how you can best put them to use.

Control Panel Pizzazz

Control panels are the primary product category for adding new features to your PC while helping you converge your computer's existing capabilities and system data. These panels provide features such as component temperature tracking, fan speed control, and much more.

20-In-1 Superior Panel

Approximate street price: \$35

Sunbeam

www.sunbeamtech.com

Available from:

www.frozenscpu.com, www.xoide.com

Some panels shoot for simplicity and elegance while others, such as Sunbeam's 20-In-1 Superior Panel, attempt to cram as many features as possible into your drive bay. This product has so many ports and capabilities that it resembles a digital Swiss Army knife.

For starters, the panel has four flash card slots that accept nine flash card types and transfer data at USB 2.0 speed. There are two USB 2.0 ports, a FireWire port, a Video-Out port, and even two SATA

connectors for external hard drives and other similar devices. There are three audio ports, including Line-out, Line-in, and Mic connectors.

A small blue LCD on the right side of the panel displays temperature and fan speed information. The two-channel fan controller will help you control fan speeds, and should a fan failure or overheating problem arise, alarms will sound. The panel provides a maximum of 10W per channel.

Of course, Sunbeam bundles all of the cables you need to connect these features to your motherboard, including the fan



20-In-1 Superior Panel

cable extensions that some companies omit. You also receive a users manual, driver CD, sensor labels, and plastic ties to help you keep things tidy.

MX6 Series Panel

Approximate street price: \$110

Matrix Orbital

www.matrixorbital.com

Available from:

www.frozenscpu.com, www.crazyipc.com

A lot of front-panel products have integrated LCDs that display pertinent system information. Unfortunately, most of these devices use VFD (vacuum-fluorescent display) technology that makes things hard to read due to ghosting and lag time. The MX6 Series USB displays from Matrix Orbital, however, use PLED (Polymeric LED) technology that provides brighter characters should be much easier to read.

The front of the MX6 has a four-way keypad, two Function buttons, and an Enter button. It also has that bright display, which shows up to 20 x 2 (horizontal x vertical) characters simultaneously. Using the included software, you can program the MX6 to display a massive rotation of information, from component temperature to customized slogans and graphics.

The unit includes an external USB cable, mounting hardware, and software CD. Optional accessories include temperature probes (\$9.95), internal USB cable (\$8.25), and LED indicator expansion (\$12.95).

Logisys 3.5-Inch Bay Fan Controller

Approximate street price: \$25

Logisys

www.logisyscomputer.com

Available from:

www.xoxide.com, www.xpcgear.com

Most front-panel devices are designed for 5.25-inch drive bays, but if you've already filled those bays with drives, you're out of luck. Unless, of course, you can find panels for your 3.5-inch bays.

We located a 3.5-inch fan controller from Logisys. This controller has a bright-blue display that shows you temperature sensor readings, fan speeds, time, and more. It also lets you control fan speed and set temperature thresholds that if exceeded will set off overheating alarms. The limited size of the faceplate leaves little real estate for lots of controls, so this panel has just two buttons to help you with setup.

Enermax 3.5-Inch Multifunction Panel

Approximate street price: \$25

Enermax

www.maxpoint.com

Available from:

www.xpcgear.com, www.pcxextreme.com

Enermax also makes a 3.5-inch control panel. This model (UC-A3FATR2) has a small blue status display that will give you temperature readings from three sensors and also offers heads-up on fans speeds.

As with other small control panels this one has a fairly simple setup. You use two primary knobs to control fan rotation and then cycle through the Mode and Set buttons to engage the other features, such as

overheat alarms, although these alarms reset to their default values every time you restart your computer.

This aluminum panel provides 10W per channel. Each temperature sensor comes with a label sticker that helps you figure out which internal component you should apply the sensor to. Enermax includes special thermal tape for this task.

Front Power Panel

Various manufacturers

Approximate street price: \$10

Available from:

www.froencpu.com, www.directron.com

True geeks are always tearing their PCs open to mess with the electronic guts, but even hardcore enthusiasts tire of dismantling the case just to power up a new component for a minute or two. With a front power panel, you can put a stop to this kind of frustration.

MX6 Series Panel



These come from a number of manufacturers and have varying configurations. One model slips into a 5.25-inch drive bay, and has a four-pin Molex connector and a standard 3-pin connector. Of course, you'll still have to turn off your computer before you connect anything to these plugs, but to test fans, drives, or any other standard-power component, you won't need to open the case. You'll find similarly priced versions with Molex-only connectors, and those with SATA ports, too.

CoolerMaster Musketeer 2

Approximate street price: \$35

CoolerMaster

www.coolermaster.com

Available from:

www.froencpu.com, www.xoxide.com

Digital readouts for front-panel controllers are great, but if you've seen one blocky digital alphanumeric character, you've seen 'em all. That's why the analog Musketeer displays from CoolerMaster are so intriguing.

The Musketeer 2 fits 5.25-inch drive bays and has three analog dials separated by two volume control sliders. The middle dial connects to your hard drive and indicates drive activity, and the left and right dials show audio output levels from your sound card. Unlike many controllers, this one doesn't give you any power over fan speed.

There are many illuminated displays that clash with your PC's existing color scheme, but the Musketeer 2 lets you choose from seven different background colors. You can select red, blue, green, yellow, light blue, purple, or white. If you want a full-fledged extravaganza you can set the device to cycle between all of the colors. For even better color matching, you can choose from a silver or black faceplate.

Zalman Fan Mate

Approximate street price: \$7

Zalman

www.zalmanusa.com

Available from:

www.xoxide.com, www.directron.com

Some case fans come with miniature knobs that let you adjust your fans' rpm speeds, but these are few and far between, and sometimes those controllers consume extra space in your PC. Front-panel fan controls are nice, too, but only if you have a free bay for installation. Thus, the Fan Mate from Zalman is a nice compromise for fan speed control.

This product is basically an adjustable resistor that comes in a small plastic box. You connect the Fan Mate to just about any three-prong fan plug and then you can manually control how fast the fan blades spin. The Fan Mate is about 5 inches long, so it's not incredibly small, but it is small enough to tuck behind other internal components. Its output is rated for 5 to 11V at 6W.

Sunbeam Lightbus

Approximate street price: \$30

Sunbeam

www.sunbeamtech.com

Available from:

www.crazyipc.com, www.xoxide.com

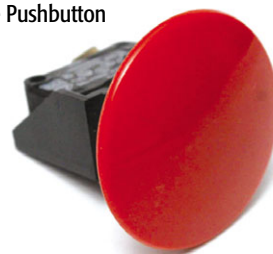
Whether you're looking to re-create "Saturday Night Fever" or want to create

a creepy haunted house inside your box, no modded PC is complete without some sort of lighting effects. Sunbeam's Lightbus lets you put on a light show worthy of a midnight rave.

Sunbeam's Lightbus lets you drastically alter the way your current lighting setup works. This four-channel light controller slides into an empty 5.25-inch drive bay and lets you dictate how you want its five lighting effects (On, Off, Sound Reactive, Hard Drive Reactive, Fade In/Out) to work on your various bulbs. These modes mean you can create more than 600 lighting routines.

The Lightbus comes equipped with four primary control knobs, each of which is surrounded by four buttons that let you configure each light's behavior individually. The knobs themselves let you adjust each light's brightness, and if you prefer, you can also connect the unit

Large Pushbutton



to your fan and use the knobs to control rpm rates instead. In addition, each knob has a backlight that makes the entire faceplate glow in a darkened computer room. To the side of the panel, you'll find two ALT buttons that cycle the lighting effects from one channel to the others.

You have a choice of either a black or silver faceplate. The Lightbus comes with mounting hardware and wiring extensions to help you complete the installation.

Pop That Switch

So now your heavily modded PC has a dozen snazzy lights, super-glow fans, and other eye-catching accoutrements. But there's one problem: The switches for each component are completely boring. Adding new switches with aesthetic flair will raise your PC's coolness factor exponentially, and better yet, many switches require only

modest soldering and tool skills for a safe, tidy installation.

Military-Style Toggle Switch

Approximate street price \$10 to \$15

Various manufacturers

Available from:

www.directron.com, www.xoxide.com

Your dreams of growing up to be a Top Gun pilot might never have materialized, but that doesn't mean you can't add fighter plane mystique to your PC. You can install a military-style toggle switch capable of controlling various PC components. A number of retailers offering various versions of these switches in different colors and with or without LEDs imbedded on the tips of the switches.

hole and uses 15A at 12V. If you have a clashing color scheme, you should know the button also comes in green, but you could feasibly paint the button any color you'd like.

Illuminated Toggle Switches

Approximate street price: \$6

Various manufacturers

Available from:

www.directron.com

Also in the '80s, you saw a multitude of sci-fi and war movies with sets that included large, computerized panels, behind which vicious aliens and human generals flicked glowing switches to unleash devastation. These illuminated toggle switches offer the same effect, only instead of nuking Mars, you'll be

LEDs, so you won't have problems finding one to match your color scheme. These products also have a low profile, so they won't stick out and make it look like your case has odd protuberances sprouting on the front. The rocker switches we bought were rated for 16A at 12V and required a 21mm installation hole.

TouchOne

Approximate street price: \$20

VLSys

www.vlsys.co.kr

Available from:

www.xoxide.com

Switches are, by and large, pretty ordinary devices that don't seem to have a lot of room for improvement. However, the VL System TouchOne takes your PC's power switch to a whole new level.

This switch uses capacitive switch technology that's activated by the touch of your skin. It has a metallic, fingerprint-resistant finish and a surface area that's a little more than 1 inch in diameter. There are no moving parts whatsoever, and when you touch the button it creates a bright blue flash to confirm activation.

The TouchOne requires continuous access to a 5V rail from your PSU, so you'll have to do some careful fiddling inside your case before it will work. Once you've installed it, you'll have one of the coolest power buttons ever to grace a computer. What's more, if you're a security-minded individual, you can mount the TouchOne in an obscure place on your case and no one will know exactly how to power on your PC.

Ultimate Control

There are a multitude of products you can use to control your PC's various components. You can keep tabs on temperature, spin your fans, drastically alter your power button, or add a variety of control gadgets that will accentuate your case design. With some careful consideration for your PC's needs and a few gentle PC case alterations, you can take ultimate control of both your computer's functionality and aesthetics at the same time. **CPU**

by Nathan Chandler



Our favorite military-style switch, though, is the carbon-fiber model that has a unique pattern on the surface of the switch guard. Flip up this fancy switch guard, flick the metal toggle switch, and the connected component will come to life.

Large Pushbutton

Approximate street price: \$10

Various manufacturers

Available from:

www.directron.com

If you're old enough to remember the early '80s, before the U.S.S.R. fell, you likely had a few nuclear-war nightmares with visions of The Button. Now you can bring your childhood fears to life, with a large red pushbutton from Directron.

This large (1.6-inch diameter) button has a mushroom (or mushroom-cloud)-shaped head and resembles emergency shutoff switches at some gas stations. The switch requires a 0.5-inch mounting

powering up, say, a case fan or other device of your choice.

These toggle switches come in various colors and light up when you flip the aluminum handle. The base fits a 0.5-inch mounting hole, and the switch uses 20A at 12V. If you're so inclined, it would be easy to match these switches to the color of a case light you want to activate.

LED Rocker Switches

Approximate street price: \$5

Various manufacturers

Available from:

www.directron.com, www.pctoys.com

Fancy switches are all good, but elegantly decorated systems demand switches with more subdued aesthetics. To that end, you'll find an entire range of rocker switches from several online retailers.

Rocker switches offer a number of advantages. They come in a variety of colors, and often with different colors of embedded

From Bland To Grand

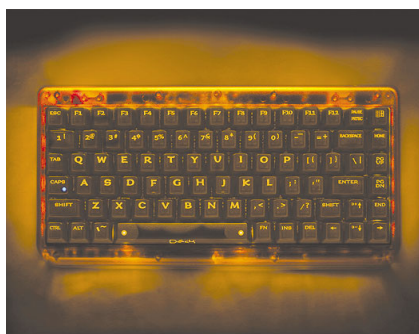
Keyboard & Mouse Mods

Let's face it: Beige keyboards and mice are just plain boring, especially when they're attached to a gorgeous mod that you've spent countless hours perfecting. Of course, you can always mod a keyboard and mouse, but sometimes you just want to be able to sit back and enjoy your new system. The easy solution? Purchase a keyboard and mouse that look good with your system. If you look around, you're sure to find plenty of unique keyboards and mice at retailers that complement your new mod. Here's a few that we found.



Talk about a modifiable keyboard; the Zboard (\$49.99; www.zboard.com) can change in a snap to fit your mod. For serious gamers, this keyboard has both form and function, with the ability to support specialized keysets or a standard keyset. The Zboard comes with a generic gaming keyset and a standard QWERTY keyset. For times when you want to squash the competition in Doom 3 or EverQuest II, just pop in

the corresponding Limited Edition Keyset (\$149.99) and go to town.



This 82-key keyboard is great for modders and gamers alike. Not only does DéCK (www.deckkeyboards.com) let you mod your keyboard, the company encourages it by giving you suggestions and instructions on how to do so. DéCK Backlit Keyboards are available in Gold (yellow; \$99), Fire (red; \$99), and Ice (blue; \$119). These keyboards have LED lights to illuminate both the housing and underside of the keycaps. Because there's an LED for each key to light the individual characters, you'll never have to deal with your letter labels rubbing off again.



The Kinesis Evolution Track-Mount Keyboard (\$569; www.kinesis-ergo.com) is an ergonomically designed keyboard that is fully adjustable. Use it in a mod

that can't take a flat keyboard and you've got the best of ergonomics and looks. This keyboard has a full range of movement in all three planes, so you're sure to be able to tilt it whichever way you please. You can also separate the keyboard slightly between the G and H keys for added flexibility. For gamers, this keyboard has unlimited key remapping and up to 24 macros. There are three models available: one with a left touchpad, one with a right touchpad, and one with dual touchpads.



If you're looking for a keyboard that can be split apart with unlimited separation, the Kinesis Evolution Desktop Keyboard (\$289) is just what you need. Choose a model with one (left or right), two, or no built-in touchpads to fit your mod. Once you've fit the keyboard to your mod, go to town modding the keyboard layout with unlimited key remapping and up to 24 macros.



Saitek's Eclipse keyboard (\$59.95; www.saitekusa.com) is sexy and sleek with its black finish and silver keys. This 104-key keyboard has blue LED key illumination and backlighting, making it perfect for day or night gaming. The lighting is adjustable between high, low, and off settings. The keyboard also has zero-slope design, an adjustable keyboard angle, and an adjustable wrist rest for comfort.



GrandTec USA's Virtually Indestructible GlowType Keyboard (\$49.99; www.grandtec.com) is a silicon-based flexible keyboard that is washable, rollable, and very durable. It has 109 keys, Windows Hotkeys, and a key to toggle the Illumination on and off. This keyboard looks really cool at night when it's glowing. It's great for the neat freaks and the klutzes alike, as it can handle cleaning solutions, water, and coffee without complaint.



Lighted keyboards are a good way to add some flair to your mod. Sunbeam's Multimedia Lite-Up Keyboard (\$19.99; www.sunbeamtech.com) comes in a black or silver finish and features a nice glow. It has what Sunbeam calls "soft and reliable

membrane contact technology" for comfort while typing. In addition, this 108-key keyboard also has ACPI keys for speedy power management.



The UFO Mouse (\$9.99; www.razotech.com) from Razotech commands attention at night. With its 10 ultra-bright, rotating LEDs, this mouse doesn't really blend in. In fact, it very clearly stands out. It doesn't sacrifice beauty on behalf of functionality, either. It has advanced optical transmitting

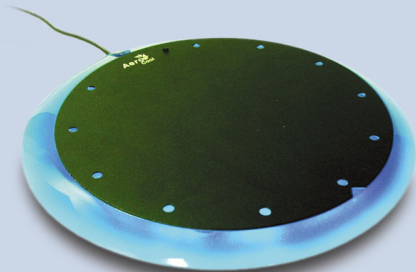
technology with 800dpi resolution to ensure that the mouse provides accurate input and moves smoothly across a variety of surfaces.



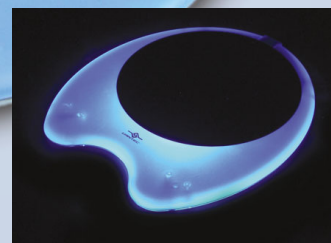
The FlexiGlow xRaider Gaming Mouse (\$19.99; www.flexiglowhk.com) is as useful as it is beautiful. This mouse has an illuminated status light that changes colors. When paired with the complementing FlexiGlow xRaider Mouse Pad (\$24.99), this mouse really shines. For comfort, this mouse features

Extraordinary Mousepads

You didn't really think that just because you were done modding your PC, keyboard, and mouse that you were done, did you? If you're going all-out for a cool machine, don't scrimp. Make sure to get a mousepad that's equally as cool. Check these pads out.



The AeroCool AeroBase (\$19.99; www.aerocool.us) isn't your average mousepad. It has 11 blue LEDs encircling it that can flash in 15 distinct sequences. Because you're probably wondering, yes you can turn the LEDs off, which is a necessity if you sleep anywhere near your PC. Music enthusiasts will love the mobile phone alert that's built in. Now you can crank your music and not miss a call, even if your tunes drown out the phone's ringer. If there's a call coming in and the phone is within 5cm of the mousepad, the LEDs will begin flashing three times faster.



The Spectrum Mouse Pad (19.99; www.vantecusa.com) gets its power from its USB connection. If you're wondering why on earth anyone would need a powered mousepad, the reason is simple: for the ultra-bright, blue cold-cathode lights around the edges. This mousepad has a sleek design and also features an additional USB port, so you're not giving up a valuable port by using it. Because a mousepad that doesn't provide traction is, well, useless, the Spectrum Mouse Pad features a PVC surface for heightened response. ▲

A Perfect Match

For times when you just have to have a keyboard and mouse that perfectly complements your system, you'll probably have to do it yourself. Check out these personalized keyboard and mouse mods.



Magnus Persson aka [WP@]WOLVERINE spent a lot of time on his Puzzlebox PC mod (featured on the cover of the March issue of *CPU*). Not only did he mod his PC, he also modded his keyboard, mouse, and monitor to match perfectly with his system. The mod was built as a tribute to Persson's favorite horror movie, "Hellraiser," and to its Pinhead character. The front surface of the mouse even features a ghostly face. Persson figured that the keyboard mod took about 30 hours to complete, and that the mouse took about 10 hours. Needless to say, Persson paid close attention to all of the fine details. It paid off in a perfectly polished mod.

You don't have to have a shiny new finish to have a cool-looking PC. Just ask Derek Thanstrom aka GK>Clockwerk Rat. His Fragmatatron mod was created based on a vision of an old Victorian or early industrial piece of electronics. He describes the theme as "Jules Verne's Time Machine" to convey what he was going for. This mod idea came from Thanstrom's father's love for early WWI and WWII surplus electronics. Given the fact that Thanstrom grew up in a household full of early electronics, he had plenty of good reference material to work off of when completing this mod. To make the system blend together perfectly, Thanstrom gave his keyboard an equally rusted look. ▲



an ergonomic shape, easy-grip rubber-coated buttons, and an illuminated scroll wheel with built in calibration control. The xRaider's good looks don't come at the expense of performance, either. The xRaider features a high-performance Optical Accelerator to handle mouse movements with maximum response. This mouse also includes a carry bag for traveling to LAN parties.



Sunbeam's Fireline Optical Mouse (\$9.99) has a simple design with a single lighted strip down its center, through the scroll wheel. This mouse comes in red or blue and features 800dpi resolution for

accurate positioning. Although it looks relatively basic, sometimes, as we must all admit, basic is good. This mouse moves away from beige, but still retains the comfortable shape and feel we've come to love from our boring mice.



Sometimes, we just want a mouse that stands out. The Sunbeam Acrylic Optical Mouse (\$11.99) does just that. With a transparent finish by day and a red-and-blue illuminated look by night, this mouse is sure to be noticed. You can even adjust its scrolling wheel vertically or horizontally. **CPU**

by Jennifer Johnson

Badges Of Honor

Cool Case Badges & Stickers

With such a wide variety of computer accessories available today, a mod is far from over when the last thumbscrew is tightened. Case badges used to be neat little advertisements for your favorite hardware. Now, however, categories have become so specific that case badges and appliques

are no longer small promotions for computer products, but bold statements of your personality.

If you're looking for a groovy way to exercise your First Amendment rights, take a look at the badges, wraps, and appliques we found.

Aluminum Case Badges

These stylish badges can give your case an extra flash. Who ever thought RC Cola cans could have a second life as something so cool?

Chrome

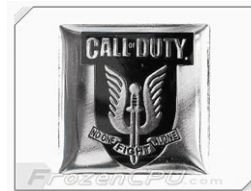
Similar to the aluminum adhesives, these chrome case badges can add a little bling to anyone's case.

Copper

This is a relatively new type of case badge. As the name suggests, these images are embossed on a copper plate and covered with bubble domes to accentuate the 3D feel.



Title	Biohazard	Warning: Overclocked
Material	Aluminum	Aluminum
Size (inches)	1 x 1	1 x 1
Price	\$3.99	\$5.50
Available at	www.directron.com	www.pccasegear.com



Title	Call of Duty	Linux
Type	Chrome	Chrome
Size (inches)	1 x 1	1 x 1
Price	\$3.75	\$3.75
Available at	www.frozenscpu.com	www.frozenscpu.com



Title	Yin Yang	Unreal Tournament
Material	Embossed Copper	Embossed Copper
Size (inches)	1.37 x 1.37	1.37 in diameter
Price	\$2.99	\$3.99
Available at	www.directron.com	www.directron.com



Title	Texas	Texas A & M
Type	Plastic Dome	Plastic Dome
Size (inches)	1 x 1	1 x 1
Price	\$1.99	\$1.99
Available at	www.directron.com	www.directron.com



College Badges

If you feel that your team hat, T-shirt, jacket, license plate liner, coffee mug, and bed sheets aren't conveying your die-hard allegiance to your favorite college team, or if you're just looking for a little something for your PC that hints at your school spirit, these college case badges will work nicely.

Gold

In keeping with the theme of precious metals, gold case badges are gaining popularity. The amber hue that these babies emit is sure to brighten your day or night.

Holograms

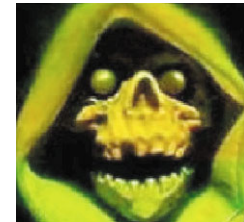
These holographic badges can add a sense of eeriness to any case. For best results don't use a case badge light to light these up, but instead use lighting from outside the case to see these images come to life.

Glow In The Dark

Glow-in-the-dark computer badges work like most other glow in the dark devices. They store light and then when the badge is cut off from the light source it glows. Simple . . . yes, but it is a very effective mood-setter for a late night gaming session.



Title	Atomic	Radioactive
Type	Gold	Gold
Size (inches)	1 x 1	1 x 1
Price	\$3.75	\$3.75
Available at	www.frozenscpu.com	www.frozenscpu.com



Title	UFO	Hooded Skull
Type	Holographic Badge	Holographic Badge
Size (inches)	15/16 x 15/16	15/16 x 15/16
Price	\$6.49	\$6.49
Available at	www.crazyipc.com	www.crazyipc.com



Title	Quake III	Skull & Crossbones
Type	Glow In The Dark	Glow In The Dark
Size (inches)	1 x 1	1 x 1
Price	\$8.48	\$3.75
Available at	www.overclockers.co.nz	www.maxdy.com



Title	EL Flame
Type	EL Case Badge
Size (inches)	1 x 1
Price	\$6.99
Available at	www.geeks.com

EL Case Badges

If you have a few extra watts in your power supply that you're looking to use, check out the EL badges. Most are the same size as normal case badges, but they also implement a tiny EL light with a 4-pin Molex connection.

Appliqués

While not a bona fide case badge, these decals are still pretty cool. Some window mod kits will include these stickers, but you don't necessarily have to be installing a window kit to get one. If you have a window that is showing nothing more than the fracas that seems to be going on among your case wires, consider one of these decals to dress it up a little bit.

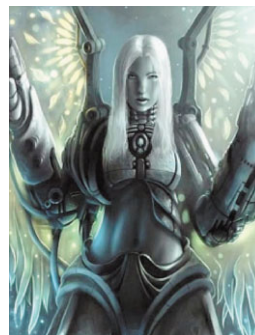
Case Wraps/Skins

Think of these guys as case badges on steroids. This is a great way to liven up a bland, beige box. Oftentimes these designs will come in a few different dimensions to better suit the various case form factors. No matter what the size of your case, there is no better way to cover up surface area than with one of these killer designs. **CPU**

by Sam Evans



Title	Counter Strike	Thundercats	Batman
Type	UV Reactant Appliqué	Window Decal	Window Appliqué
Size (inches)	7.5 in diameter	7 in diameter	N/A
Price	\$5.89	\$6.95	\$8.95
Available at	www.xoxide.com	www.atacom.com	www.performance-pcs.com



Title	Nightmare	Wings Of Fate	American Flag
Type	Case Wrap	Case Wrap	Case Wrap
Size (inches)	19.5 x 50; 19.5 x 21	19 x 17.5; 24 x 17.5	Varies according to case size
Price	\$55.50; \$20.00	\$29.95; \$25.95	\$54.99
Available at	www.cyberguys.com	www.casecooler.com	www.xoxide.com

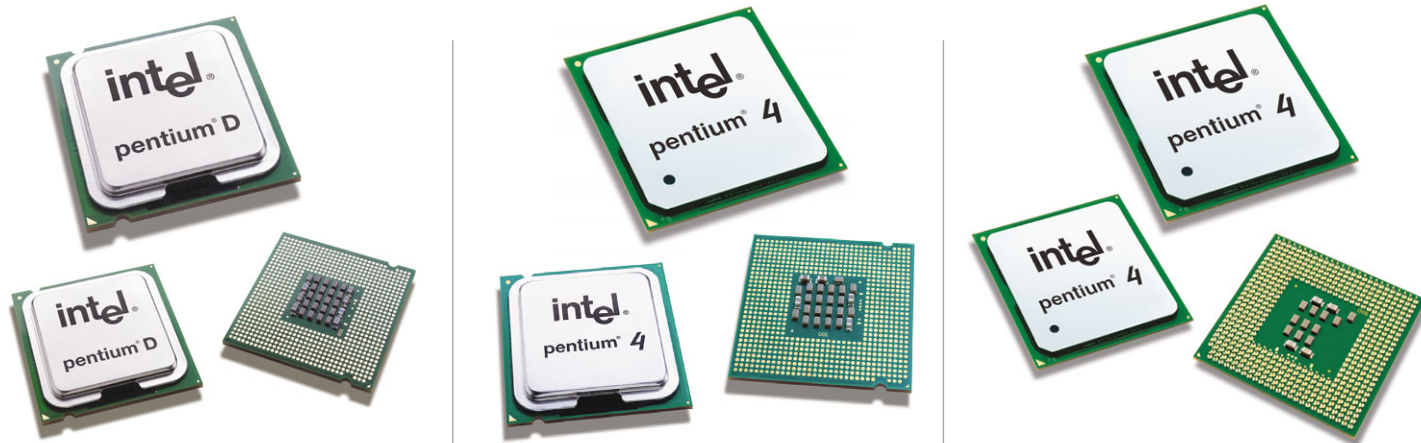
Intel Processors

Intel has introduced quite a few new processors since our last edition of *PC Modder*. These new chips are all based on the 90nm manufacturing process, with the exception of one Xeon MP processor which is still using the 130nm process. The chipsets for these

processors have continued to improve, with most new chipset and processor combinations now supporting dual-channel DDR2 RAM. **CPU**

Compiled by Jennifer Johnson

Processor Family	Intel Pentium 4 Processor with HT Technology	Intel Pentium 4 Processor with HT Technology	Intel Celeron D Processor	Intel Celeron D Processor	Mobile Intel Pentium 4 Processor	Intel Xeon Processor	Intel Xeon Processor
Product Name	571	570	346	345/345J	552	N/A	N/A
Clock Speed	3.80GHz	3.80GHz	3.06GHz	3.06GHz	3.46GHz	3.60GHz	3.40GHz
Code Name	Prescott	Prescott	Prescott	Prescott	Prescott	Irwindale	Irwindale
Date Of Introduction	Nov. 15, 2004	Nov. 15, 2004	Nov. 23, 2004	Nov. 23, 2004	Jan. 4, 2005	Jan. 14, 2005	Jan. 14, 2005
System Bus (MHz)	800MHz	800MHz	533MHz	533MHz	533MHz	800MHz	800MHz
Cache	1MB L2	1MB L2	256KB L2	256KB L2	1MB L2	2MB integrated L2	2MB integrated L2
Socket Type	LGA775 (Socket T)	LGA775 (Socket T)	LGA775 (Socket T)	mPGA 478 (Socket 478)	mPGA479 (Socket 478M)	mPGA604 (Socket 604)	mPGA604 (Socket 604)
Manufacturing Technology	90nm	90nm	90nm	90nm	90nm	90nm	90nm
Supported Memory	dual-channel DDR2-533/400, dual-channel DDR400/333	dual-channel DDR2-533/400, dual-channel DDR400/333	dual-channel DDR2-533/400, dual-channel DDR400/333 (depending on chipset)	DDR400/333/266/200 SDRAM, PC133 SDRAM, dual-channel DDR400/333/266, dual-channel DDR2-533/400, unbuffered dual-channel DDR2-533/400, unbuffered dual-channel DDR 400/333 (depending on chipset)	up to 2GB of DDR333/266/200	quad-channel DDR, DDR2, up to 64GB	quad-channel DDR, DDR2, up to 64GB
Target Market	desktops and entry-level workstations	desktops and entry-level workstations	value and mobile PCs	value and mobile PCs	full-sized and desktop replacement mobile PCs	dual processor server and workstation applications	dual processor server and workstation applications
Features	HT Enabled, Intel Extended Memory 64 Technology (EM64T), Execute Disable Bit (NX)	HT Enabled, NX	EM64T, NX, Data Flow Analysis, Speculative Execution, Non-Blocking Level 1 Cache, SSE3, DIB (Dual Independent Bus)	SSE3, Level 1 Execution Trace Cache, DIB, NX (with 345J)	HT Technology, EIST (Enhanced Intel SpeedStep Technology)	Intel NetBurst micro-architecture, HT Technology, Advanced Dynamic Execution, Hyper Pipelined Technology, EM64T, DBS (Demand-Based Switching) with EIST, SSE2, SSE3	Intel NetBurst micro-architecture, HT Technology, Advanced Dynamic Execution, Hyper Pipelined Technology, EM64T, DBS with EIST, SSE2, SSE3
Number Of CPUs Supported	1	1	1	1	1	1, 2	1, 2
Chipset	Intel 945P Express, 945G Express, 925XE Express, 925X Express, 915G Express, 915GV Express, 915GL Express, 915P Express, 915PL Express	Intel 945P Express, 945G Express, 925XE Express, 925X Express, 915G Express, 915GV Express, 915GL Express, 915P Express, 915PL Express	Intel 915GV Express, 915GL Express, 915G Express, 915PL Express, 915P	Intel 915GV Express, 915G Express, 915P Express, 910GL Express, 865PE, 865P, 865GV, 865G, 848P, 845PE, 845GV, 845GE, 845G, 845E, E7221	Intel 852GME, 852PM	Server Chipset: Intel E7520, E7320 Workstation Chipset: Intel E7525	Server Chipset: Intel E7520, E7320 Workstation Chipset: Intel E7525



Intel Xeon Processor	Intel Xeon Processor	Intel Pentium M Processor	Intel Pentium M Processor	Intel Pentium M Processor	Intel Pentium M Processor	Intel Pentium M Processor	Low Voltage Pentium M
N/A	N/A	770	760	750	740	730	758
3.20GHz	3.00GHz	2.13GHz	2.00GHz	1.86GHz	1.73GHz	1.60GHz	1.50GHz
Irwindale	Irwindale	Dothan	Dothan	Dothan	Dothan	Dothan	Dothan
Jan. 14, 2005	Jan. 14, 2005	Jan. 19, 2005	Jan. 19, 2005	Jan. 19, 2005	Jan. 19, 2005	Jan. 19, 2005	Jan. 19, 2005
800MHz	800MHz	533MHz	533MHz	533MHz	533MHz	533MHz	400MHz
2MB integrated L2	2MB integrated L2	2MB L2	2MB L2	2MB L2	2MB L2	2MB L2	2MB L2
mPGA604 (Socket 604)	mPGA604 (Socket 604)	Socket 478	Socket 478	Socket 478	Socket 478	Socket 478	Socket 478
90nm	90nm	90nm	90nm	90nm	90nm	90nm	90nm
quad-channel DDR, DDR2, up to 64GB	quad-channel DDR, DDR2, up to 64GB	DDR2-533/400, up to 2GB of DDR 333/266/200 (depending on chipset)	DDR2-533/400, up to 2GB of DDR 333/266/200 (depending on chipset)	DDR2-533/400, up to 2GB of DDR 333/266/200 (depending on chipset)	DDR2-533/400, up to 2GB of DDR 333/266/200 (depending on chipset)	DDR2-533/400, up to 2GB of DDR 333/266/200 (depending on chipset)	DDR2-533/400, up to 2GB of DDR 333/266/200 (depending on chipset)
dual processor server and workstation applications	dual processor server and workstation applications	full-sized and thin-and-light mobile PCs	full-sized and thin-and-light mobile PCs	full-sized and thin-and-light mobile PCs	full-sized and thin-and-light mobile PCs	full-sized and thin-and-light mobile PCs	mininotebooks, subnotebooks, and tablet PCs
Intel NetBurst micro-architecture, HT Technology, Advanced Dynamic Execution, Hyper Pipelined Technology, EM64T, (DBS) with EIST, SSE2, SSE3	Intel NetBurst micro-architecture, HT Technology, Advanced Dynamic Execution, Hyper Pipelined Technology, EM64T, (DBS) with EIST, SSE2, SSE3	Intel SpeedStep Technology, NX support, support for Intel Mobile Voltage Positioning (Intel MVP IV)	Intel SpeedStep Technology, NX support, support for Intel MVP IV	Intel SpeedStep Technology, NX support, support for Intel MVP IV	Intel SpeedStep Technology, NX support, support for Intel MVP IV	Intel SpeedStep Technology, NX support, support for Intel MVP IV	Intel SpeedStep Technology, NX support, support for Intel MVP IV
1, 2	1, 2	1	1	1	1	1	1
Server Chipset: Intel E7520, E7320 Workstation Chipset: Intel E7525	Server Chipset: Intel E7520, E7320 Workstation Chipset: Intel E7525	Mobile Intel 915 Express Chipset Family, Intel 855 Chipset Family	Mobile Intel 915 Express Chipset Family, Intel 855 Chipset Family	Mobile Intel 915 Express Chipset Family, Intel 855 Chipset Family	Mobile Intel 915 Express Chipset Family, Intel 855 Chipset Family	Mobile Intel 915 Express Chipset Family, Intel 855 Chipset Family	Mobile Intel 915 Express Chipset Family, Intel 855 Chipset Family

AMD Processors

AMD introduced new Athlons and Semprons since our last issue, but probably the biggest news is the introduction of the new Turion 64 line of processors. The Turion 64 line is positioned to directly compete with Intel's Centrino line of processors.

Because the Turion 64 line is both 32-bit and 64-bit compatible, this processor is ready to compete both now and in the future. **CPU**

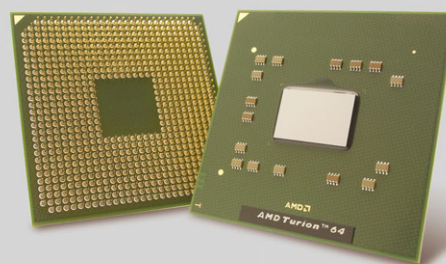
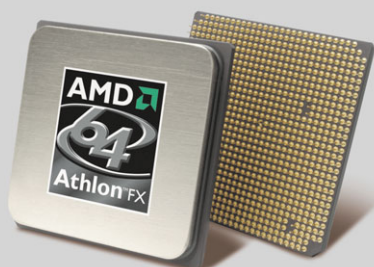
Compiled by Jennifer Johnson

Processor Family	AMD Athlon 64	AMD Turion 64 Mobile Technology	AMD Turion 64 Mobile Technology	AMD Turion 64 Mobile Technology	AMD Turion 64 Mobile Technology
Model Name	FX-57	ML-40	ML-28	ML-28	MT-28
Code Name	San Diego	Lancaster	Lancaster	Lancaster	Lancaster
Date Of Introduction	June 27, 2005	June 22, 2005	June 22, 2005	June 22, 2005	June 22, 2005
Memory Controller Bit Width	128-bit	64-bit + 8-bit ECC	64-bit + 8-bit ECC	64-bit + 8-bit ECC	64-bit + 8-bit ECC
Clock Speed	2.8GHz	2.2GHz	1.6GHz	1.6GHz	1.6GHz
HT Speed	1,000MHz	1,600MHz	1,600MHz	1,600MHz	1,600MHz
Cache	1MB L2	128KB L1, 1MB L2	128KB L1, 512KB L2	128KB L1, 512KB L2	128KB L1, 512KB L2
Socket Type	Socket 939	Socket 754	Socket 754	Socket 754	Socket 754
Process Technology	90nm	90nm SOI	90nm SOI	90nm SOI	90nm SOI
Transistors (in millions)	113	114	114	114	114
Supported Memory	unbuffered PC3200, PC2700, PC2100, or PC1600	PC3200, PC2700, PC2100, or PC1600 so-DIMMs	PC3200, PC2700, PC2100, or PC1600 so-DIMMs	PC3200, PC2700, PC2100, or PC1600 so-DIMMs	PC3200, PC2700, PC2100, or PC1600 so-DIMMs
Target Market	gaming	highly mobile business professionals	mobile PCs	mobile PCs	mobile PCs
Features	3DNow! Professional technology, Cool'n'Quiet technology, EVP (Enhanced Virus Protection), HyperTransport technology, SSE2, SSE3	3DNow! Professional technology, AMD PowerNow! Technology, EVP, SSE2, SSE3	3DNow! Professional technology, AMD PowerNow! Technology, EVP, SSE2, SSE3	3DNow! Professional technology, AMD PowerNow! Technology, EVP, SSE2, SSE3	3DNow! Professional technology, AMD PowerNow! Technology, EVP, SSE2, SSE3
# Of CPUs Supported	1	1	1	1	1

Processor Family	AMD Athlon 64 X2 Dual-Core	AMD Athlon 64 X2 Dual-Core	AMD Athlon 64 X2 Dual-Core	AMD Athlon 64 X2 Dual-Core	Dual-Core AMD Opteron Processor
Model Name	4800+	4600+	4400+	4200+	275
Code Name	Toledo	Manchester	Toledo	Manchester	Italy
Date Of Introduction	May 31, 2005	May 31, 2005	May 31, 2005	May 31, 2005	May 31, 2005
Memory Controller Bit Width	128-bit	128-bit	128-bit	128-bit	128-bit
Clock Speed	2.4GHz	2.4GHz	2.2GHz	2.2GHz	2.2GHz
HT Speed	2,000MHz	2,000MHz	2,000MHz	2,000MHz	1,000MHz
Cache	128KB L1, 1MB + 1MB L2	128KB L1, 512KB + 512KB L2	128KB L1, 1MB + 1MB L2	128KB L1, 512KB + 512KB L2	2MB L2
Socket Type	Socket 939	Socket 939	Socket 939	Socket 939	Socket 940
Process Technology	90nm SOI	90nm SOI	90nm SOI	90nm SOI	90nm SOI
Transistors (in millions)	154 to 233.2 (depending on cache size)	154 to 233.2 (depending on cache size)	154 to 233.2 (depending on cache size)	154 to 233.2 (depending on cache size)	Approx. 223.5
Supported Memory	unbuffered PC3200, PC2700, PC2100, or PC1600	unbuffered PC3200, PC2700, PC2100, or PC1600	unbuffered PC3200, PC2700, PC2100, or PC1600	unbuffered PC3200, PC2700, PC2100, or PC1600	up to PC3200R
Target Market	prosumer and digital media segments	prosumer and digital media segments	prosumer and digital media segments	prosumer and digital media segments	two-way servers or workstations
Features	3DNow! technology, AMD 64 instruction support, EVP with supported operating systems, full duplex, HyperTransport technology, SSE2, SSE3	3DNow! technology, AMD 64 instruction support, EVP with supported operating systems, full duplex, HyperTransport technology, SSE2, SSE3	3DNow! technology, AMD 64 instruction support, EVP with supported operating systems, full duplex, HyperTransport technology, SSE2, SSE3	3DNow! technology, AMD 64 instruction support, EVP with supported operating systems, full duplex, HyperTransport technology, SSE2, SSE3	AMD64 technology with Direct Connect Architecture
# Of CPUs Supported	1	1	1	1	2

MODDER'S LIBRARY

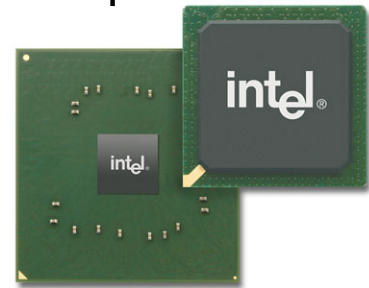
Processor Family	Dual-Core AMD Opteron Processor	Dual-Core AMD Opteron Processor	Opteron	Dual-Core AMD Opteron Processor	Dual-Core AMD Opteron Processor
Model Name	270	265	152	875	870
Code Name	Italy	Italy	Venus	Egypt	Egypt
Date Of Introduction	May 31, 2005	May 31, 2005	Apr. 30, 2005	Apr. 21, 2005	Apr. 21, 2005
Memory Controller Bit Width	128-bit	128-bit	128-bit	128-bit	128-bit
Clock Speed	2GHz	1.8GHz	2.6GHz	2.2GHz	2GHz
HT Speed	1,000MHz	1,000MHz	1,000MHz	1,000MHz	1,000MHz
Cache	2MB L2	2MB L2	1MB L2	2MB L2	2MB L2
Socket Type	Socket 940	Socket 940	Socket 940	Socket 940	Socket 940
Process Technology	90nm SOI	90nm SOI	90nm	90nm SOI	90nm SOI
Transistors (in millions)	Approx. 223.5	Approx. 223.5	114	Approx. 223.5	Approx. 223.5
Supported Memory	up to PC3200R	up to PC3200R	up to PC3200	up to PC3200R	up to PC3200R
Target Market	two-way servers or workstations	two-way servers or workstations	one-way servers and workstations	up to eight-way servers, 4P workstation environments	up to eight-way servers, 4P workstation environments
Features	AMD64 technology with Direct Connect Architecture	AMD64 technology with Direct Connect Architecture	AMD PowerNow! technol- ogy with OPM (Optimized Power Management), Direct Connect Architec- ture, HyperTransport technology, SSE3	AMD64 technology with Direct Connect Architecture	AMD64 technology with Direct Connect Architecture
# Of CPUs Supported	2	2	1	4, 8	4, 8



Processor Family	Dual-Core AMD Opteron Processor	AMD Sempron	Mobile AMD Athlon 64	Mobile AMD Athlon 64 Processor for Notebooks	AMD Turion 64 Mobile Technology
Model Name	865	3300+	3700+	3700+	ML-37
Code Name	Egypt	Palermo	Newark	ClawHammer	Lancaster
Date Of Introduction	Apr. 21, 2005	Apr. 15, 2005	Apr. 14, 2005	Apr. 14, 2005	Mar. 10, 2005
Memory Controller Bit Width	128-bit	64-bit	64-bit + 8-bit ECC	64-bit	64-bit + 8-bit ECC
Clock Speed	1.8GHz	2GHz	2.4GHz	2.4GHz	2GHz
HT Speed	1,000MHz	1,600MHz	1,600MHz	1,600MHz	1,600MHz
Cache	2MB L2	128KB L1, 128KB L2	128KB L1, 1MB L2	128KB L1, 1MB L2	128KB L1, 1MB L2
Socket Type	Socket 940	Socket 754	Socket 754	Socket 754	Socket 754
Process Technology	90nm SOI	90nm	90nm SOI	130nm SOI	90nm SOI
Transistors (in millions)	Approx. 223.5	68.5	114	105.9	114
Supported Memory	up to PC3200R	DDR400	unbuffered PC3200, PC2700, PC2100, or PC1600	PC3200, PC2700, PC2100 and PC1600 DDR unbuffered memory	PC3200, PC2700, PC2100, or PC1600 so-DIMMs
Target Market	up to eight-way servers, 4P work- station environments	entry-level PC market and home, business, and gaming buyers	full-sized notebooks	full-sized notebooks	mobile PCs
Features	AMD64 technology with Direct Connect Architecture	3DNow! Profession- al technology, EVP compatible with Microsoft Windows XP SP2, Hyper- Transport technology, SSE, SSE2, SSE3	3DNow! Professional technology, AMD PowerNow! technology, AMD64 technology, both 32- and 64-bit computing, EVP, HyperTransport technology, SSE2, SSE3	AMD PowerNow! Technology, EVP, HyperTransport technology	3DNow! Professional technology, AMD PowerNow! Technology, EVP, SSE2, SSE3
# Of CPUs Supported	4, 8	1	1	1	1

Intel-Compatible Chipsets

Intel has released quite a few new mobile chipsets in recent months, all of which support PCI Express technology. NVIDIA, ULi, ATI, and VIA have also added a handful of chipsets that feature PCI-E. There are also new chipsets on the horizon; look for more concrete details to emerge as release dates get closer. **CPU**



Compiled by Jennifer Johnson

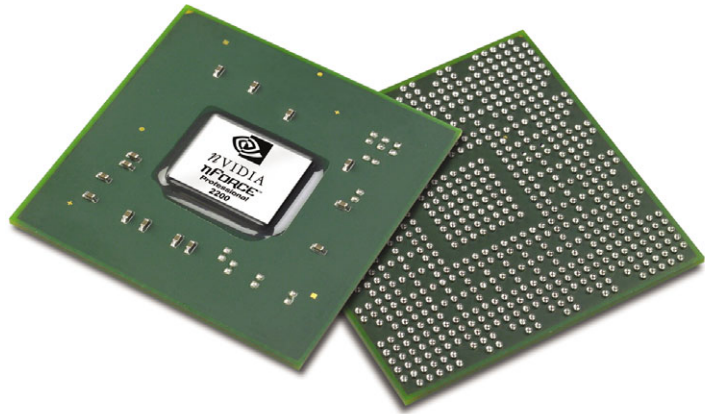
	Mobile Intel 910GML Express	Intel 915GL Express	Mobile Intel 915GM Express	Mobile Intel 915GMS Express	Intel 915PL Express	Mobile Intel 915PM Express
Code Name	Alviso	Grantsdale-G	Alviso	Alviso	Grantsdale	Alviso
Date Of Introduction	Jan. 19, 2005	Jan. 2005	Feb. 22, 2005	Jan. 19, 2005	Jan. 2005	Jan. 19, 2005
Compatible Intel Processors	Celeron M processor, Celeron M processor ULV (Ultra Low Voltage)	Pentium 4 processor, Celeron D processor	Pentium M processor, Pentium M processor LV (Low Voltage), Pentium M processor ULV, Celeron M processor, Celeron M processor ULV	Pentium M processor LV, Pentium M processor ULV, Celeron M processor ULV	Pentium 4 processor, Celeron D processor	Pentium M processor, Pentium M processor LV, Pentium M processor ULV, Celeron M processor, Celeron M processor ULV
Target Market	value notebooks	performance desktop	notebooks	small-form-factor notebooks	performance desktop	performance notebooks
Northbridge	Mobile Intel 910GML Express Chipset (GMCH)	82915GL GMCH	Mobile Intel 915GM Express Chipset (GMCH)	Mobile Intel 915GM Express Chipset (GMCH)	82915GPL GMCH	Mobile Intel 915GM Express Chipset (GMCH)
System Bus	400MHz	800/533MHz	533MHz: Intel Pentium M processor; 400MHz: Intel Pentium M processor (LV), Intel Pentium M processor (ULV), Intel Celeron M processor	400MHz	800/533MHz	533MHz: Intel Pentium M processor; 400MHz: Intel Pentium M processor (LV), Intel Pentium M processor (ULV), Intel Celeron M processor
Supported Memory	dual-channel DDR2-400, single-channel DDR333	up to 4GB dual-channel DDR400/333	up to 2GB dual/single-channel DDR2-400/533, DDR333	single-channel DDR2-400	up to 2GB DDR400/333	dual/single-channel DDR2-533/400; single-channel DDR333
Integrated Graphics	Intel GMA 900, (200MHz @ 1.05V)	GMA 900 graphics	Intel GMA 900, (200/222/333MHz @ 1.5V), (190/200/213/222 MHz @ 1.05V)	Intel GMA 900, (152/200MHz @ 1.05V)	N/A	N/A
External Graphics	N/A	N/A	PCI-E x16	N/A	PCI-E x1	PCI-E x16
HT Support	N/A	yes	N/A	N/A	yes	N/A
Southbridge	ICH6-M	ICH6, ICH6R	ICH6-M	ICH6-M	ICH6, ICH6R	ICH6-M
PCI Support	four PCI-E ports	four PCI-E ports	four PCI-E ports	four PCI-E ports	four PCI-E ports	four PCI-E ports
IDE Support	ATA/100	UDMA ATA/100	ATA/100	ATA/100	UDMA ATA/100	ATA/100
SATA	two SATA/150 ports	four SATA/150 ports	two SATA/150 ports	two SATA/150 ports	four SATA/150 ports	two SATA/150 ports
USB	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports
Audio	Intel High Definition Audio 24-bit, 192KHz, AC '97 2.3 Audio	Intel High Definition Audio, AC '97/20-bit audio	Intel High Definition Audio 24-bit 192KHz, AC '97 2.3 Audio	Intel High Definition Audio 24-bit 192KHz, AC '97 2.3 Audio	Intel High Definition Audio, AC '97/20-bit audio	Intel High Definition Audio 24-bit 192KHz, AC '97 2.3 Audio
Network Support	LAN MAC	LAN	LAN MAC	LAN MAC	LAN	LAN MAC
Storage Technology	N/A	Intel Matrix Storage Technology (RAID 0, 1)	N/A	N/A	Intel Matrix Storage Technology (RAID 0, 1)	N/A

	Intel 945G	Intel 945P Express	Intel 955X Express	Intel E7230
Code Name	Lakeport	Lakeport	Glenwood	Mukilteo
Date Of Introduction	May 26, 2005	May 26, 2005	April 18, 2005	July 11, 2005
Compatible Intel Processors	Pentium D processor, Pentium 4 processor with HT Technology, all other System Bus Pentium processors	Pentium D processor, Pentium 4 processor with HT Technology, all other System Bus Pentium processors	Pentium processor Extreme Edition, Pentium 4 processor Extreme Edition, Pentium 4 processor, Pentium D processor, and all other Pentium processors in the LGA775 socket	Pentium 4 processor with HT Technology, Pentium D processor
Target Market	performance PCs	performance PCs	highest performance platforms	entry-level server
Northbridge	82945G MCH	82945P MCH	82955X MCH	E7230 MCH
System Bus	1,066/800/533MHz	1,066/800/533MHz	1,066/800MHz	1,066/800MHz (data)
Supported Memory	dual-channel DDR2-667/533/400	dual-channel DDR2-667/533/400	up to 8GB dual-channel DDR2-667/533 with ECC support	up to 8GB unbuffered dual-channel, DDR2-667/533/400
Integrated Graphics	945G chipset, Intel Graphics Media Accelerator 950	945G chipset	N/A	N/A
External Graphics	945G chipset, PCI-E x16	945G chipset, PCI-E x16	PCI-E x16	E7230 chipset
HT Support	yes	yes	yes	yes
Southbridge	ICH7, ICH7R	ICH7, ICH7R	ICH7 or ICH7R	Intel ICH7R Family
PCI Support	four PCI-E X or six (with ICH7R) PCI-E X, six PCI masters	four PCI-E X or six (with ICH7R) PCI-E X, six PCI masters	PCI-E x16, one PCI-E x4 port (with ICH7R), two PCI-E x1 ports (with ICH7R), six PCI ports (with ICH7R)	PCI 2.3, six PCI Masters
IDE Support	one PATA	one PATA	Legacy ATA/100, one PATA port	ATA/100
SATA	four SATA (3Gbps)	four SATA (3Gbps)	four SATA ports	four SATA ports (2Gbps)
USB	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports
Audio	Intel High Definition Audio, AC '97/20-bit audio	Intel High Definition Audio, AC '97/20-bit audio	Intel High Definition Audio for full 7.1 surround sound, AC '97/20-bit audio	High Definition Audio, AC '97 2.2 compliant
Network Support	LAN	LAN	GbE and LAN MAC	1Gb LAN MAC
Storage Technology	Intel Matrix Storage Technology with ICH7R	Intel Matrix Storage Technology with ICH7R	Intel Matrix Storage Technology (with ICH7R) for RAID 0, 1, 5, 10	N/A

	Intel E8500	NVIDIA nForce4 SLI	ULi M1575 Southbridge	ATI Radeon Xpress 200M
Code Name	Twin Castle	C19	N/A	N/A
Date Of Introduction	Mar. 29, 2005	Apr. 5, 2005	May 31, 2005	Apr. 20, 2005
Compatible Intel Processors	64-bit Xeon processor MP	Pentium 4 with HT Technology (Socket 775)	Pentium 4, Pentium M, Pentium D processors	Pentium M, Celeron, Pentium 4
Target Market	server	ultimate enthusiasts	performance intensive and multitasking requirements	broad range of notebook designs including thin-and-light, performance thin, and desktop replacement
Northbridge	E8500 Chipset North Bridge	nForce4 SLI SPP	ATI's Radeon Xpress series, PCI-E northbridge, capability to switch via the built-in PCI-E x4 link	N/A
System Bus	667MHz	1,066MHz	N/A - determined by northbridge	N/A
Supported Memory	DDR333/266 (registered), DDR2-400 (registered)	dual DDR2-667 DIMMs and beyond	N/A - determined by northbridge	DDR400, DDR2-667
Integrated Graphics	N/A	N/A	N/A - determined by northbridge	N/A
External Graphics	E8500 Chipset North Bridge	PCI-E x1	N/A - determined by northbridge	PCI-E interface
HT Support	yes	yes	N/A - determined by northbridge	yes
Southbridge	ICH5	nForce4 SLI MCP	M1575 Southbridge	N/A
PCI Support	single 32-bit PCI segment, six PCI masters	two PCI-E graphics slots, three x1 PCI-E expansion slots	supports PCI master and slave interface	up to four x1 PCI-E general purpose links, PCI v2.3 (up to seven slots)
IDE Support	two-channel Ultra ATA	four ATA/133 drives	two ATA/133 ports	N/A
SATA	two ATA/150 ports	four SATA 3Gbps drives	up to four ports AHCI based SATA II 3Gbps with NCQ	SATA controller
USB	eight USB 2.0 ports	10 USB 2.0 ports	one EHCI USB 2.0, three OHCI USB 1.1, host controllers supporting up to eight USB ports	eight USB 2.0 ports
Audio	AC '97 2.3 compliant	AC '97 2.3, supports 2-, 4-, 6-, or 8-channel audio, dual AC-Link, dual SPDIF, handles stereo PCM or AC-3 output	HD Audio	AC '97 up to 7.1/5.1-channel output, MC-97 for the modem
Network Support	Integrated 10/100	10/100/1000 Ethernet	10/100 802.3x MAC, soft-modem interface	N/A
Storage Technology	N/A	RAID 5, 0, RAID 1, RAID 0+1 support	RAID 0, RAID 1, RAID 0+1, RAID 5, JBOD capabilities	RAID 0,1 function

AMD-Compatible Chipsets

There are new offerings from a myriad of manufacturers this time around. Many of these chipsets support RAID and GbE. While most of the new chipsets still focus on either the AGP or PCI Express standard for external graphics, ULI's M1695 chipset simultaneously supports both AGP and PCI-E graphics cards. Set up a dual monitor system and get some extra use out of an older AGP card that you might have stashed away. **CPU**



Compiled by Jennifer Johnson

	ATI Radeon Xpress 200M	NVIDIA nForce Professional 2050	NVIDIA nForce Professional 2200	SiS 756
Code Name	N/A	N/A	N/A	N/A
Date Of Introduction	Feb. 17, 2005	Jan. 24, 2005	Jan. 24, 2005	Mar. 8, 2005
Compatible AMD Processors	Sempron, Athlon 64, Athlon 64 FX, Turion 64 Mobile, Athlon 64 Mobile, Sempron Mobile	must be coupled with a 2200 MCP to function	Opteron	Athlon 64 FX, Athlon 64, Opteron, Sempron with HyperTransport
Target Market	graphics-intensive business and communications applications, thin-and-light notebooks	multiprocessor servers and workstations	multiprocessor servers and workstations	professional-grade servers and workstation platforms
Northbridge	Radeon Xpress 200M	nForce Professional 2050	nForce Professional 2200	SiS756
System Bus	1,000/800MHz	N/A	1GHz	1,000/800/600/400/200MHz
Memory Support	GDDR and DDR support	N/A	N/A	based on CPU
Integrated Graphics	Radeon graphics core	N/A	N/A	N/A
External Graphics	built-in graphics deliver double the bandwidth of AGP 8X	PCI-E x16	PCI-E x16	PCI-E x16
HT Support	yes	yes	yes	yes
Southbridge	N/A	N/A	N/A	SiS965 or SiS965L
PCI Support	up to four PCI-E x1 links, up to seven slots PCI v2.3	N/A	PCI 2.3-compliant, six external PCI slots at 33MHz, six-bus master arbitration	PCI-E x16, up to two PCI-E x1 slots
IDE Support	IEEE 1394	N/A	four fast Ultra ATA133 disk drive controllers	dual independent IDE channels with ATA/133/100/66/33 support
SATA	SATA controller	four 3Gbps SATA disks	four 3Gbps SATA disks	up to four SATA ports (with SiS965), up to two SATA ports (with SiS965L)
USB	eight USB 2.0 ports	none	10 USB 2.0 ports	up to eight USB 2.0/1.1 ports (one EHCI USB 2.0 controller and three OHCI USB 1.1 controllers)
Audio	AC '97 up to 7.1/5.1-channel output and MC-97 for the modem	N/A	AC '97 2.3 compliant interface, supports 2-, 4-, 6-, or 8-channel audio, dual AC-Link, dual SPDIF, handles stereo PCM or AC-3 output	AC '97 7.1-channel
Network Support	GbE	native GbE	native GbE	GbE (with SiS965), 10/100 Ethernet (with SiS965L)
Storage Technology	RAID 0, 1	RAID 0, 1, 0+1	RAID 0, 1, 0+1	RAID 0, 1, 0+1, JBOD (with SiS965), RAID 0, 1, JBOD (with SiS965L)

	SiS SiSM760	SiS SiSM761GX	SiS SiSM770	SiS SiS761GX
Code Name	N/A	N/A	N/A	N/A
Date Of Introduction	Mar. 10, 2005	Mar. 10, 2005	Mar. 10, 2005	Mar. 11, 2005
Compatible AMD Processors	Turion 64, Athlon 64 Mobile	Turion 64, Athlon 64 Mobile	Turion 64	Sempron, Athlon64, Athlon64 FX, Opteron
Target Market	thin-and-light notebooks	thin-and-light notebooks	thin-and-light notebooks	desktop PCs
Northbridge	SiSM760	SiSM761GX	SiSM770	SiS761GX
System Bus	1,600MT/s	2,000MT/s	2,000MT/s	2,000MT/s
Memory Support	N/A - determined by CPU	N/A - determined by CPU	N/A - determined by CPU	N/A
Integrated Graphics	SiS Mirage 2	SiS Mirage 1	SiS Mirage 3	SiS Mirage 1
External Graphics	8X AGP	PCI-E x16	PCI-E x16	PCI-E x16
HT Support	N/A	yes	N/A	yes
Southbridge	SiS966, SiS966L	SiS966, SiS966L	SiS966, SiS966L	SiS966
PCI Support	two PCI-E x1 ports	two PCI-E x1 ports	two PCI-E x1 ports	two PCI-E x1 ports
IDE Support	four PATA, 2-channel ATA/133	four PATA, 2-channel ATA/133	four PATA	four parallel ATA/133 standard IDE hard disks
SATA	four SATA ports	four SATA ports	four SATA ports	four SATA ports
USB	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0 ports	eight USB 2.0/1.1 ports
Audio	high-definition 7.1-channel sound	high-definition 7.1-channel sound	high-definition 7.1-channel sound	high-definition 7.1-channel sound
Network Support	10/100Mbps	10/100Mbps	10/100/1,000Mbps	10/100/1,000Mbps
Storage Technology	RAID 0, 1, 0+1, JBOD	RAID 0, 1, 0+1, JBOD	RAID 0, 1, 0+1, JBOD	RAID 0, 1, 0+1, JBOD
	ULi M1695	ULi M1575 Southbridge	VIA K8N800A	VIA K8T890
Code Name	N/A	N/A	N/A	N/A
Date Of Introduction	Apr. 13, 2005	May 31, 2005	Feb. 25, 2005	Apr. 21, 2005
Compatible AMD Processors	Athlon 64	Athlon 64 X2 dual-core, Athlon 64, Athlon 64 FX, Athlon 64 Mobile, Sempron, Turion 64, Opteron	Turion 64 Mobile, Athlon 64 Mobile, Sempron Mobile	Dual-Core Opteron, Opteron, Athlon FX, Athlon 64, Sempron (939-, 940- & 754-pin)
Target Market	mainstream desktop and mobile PCs, high-performance work-station, high-reliability servers	performance intensive and multitasking requirements	thin-and-light notebooks, high-performance notebooks	demanding entertainment and multimedia applications
Northbridge	M1695	compatible with ATI's Radeon Xpress series, PCI-E northbridge, capability to switch via the built-in PCI-E x4 link	K8N800A	K8T890
System Bus	N/A	N/A - determined by northbridge	800MHz	1GHz/16-bit (Upstream & Down-stream) HyperTransport Bus Link
Memory Support	N/A	N/A - determined by northbridge	64/128-bit dual-channel DDR memory controller integrated directly into processor	DDR memory controller integrated directly into AMD64 processor
Integrated Graphics	N/A	N/A - determined by northbridge	S3 Graphics UniChrome Pro Integrated Graphics Processor (IGP)	VIA DualGFX Express
External Graphics	simultaneous support for PCI-E x16, 8X AGP graphics interfaces	N/A - determined by northbridge	optional external AGP 8X/4X port	PCI-E x16
HT Support	yes	N/A - determined by northbridge	yes	yes
Southbridge	M1567	M1575 Southbridge	VIA VT8237R	VIA VT8237
PCI Support	one PCI-E x16 lane or two x8 lanes for graphics cards or devices, supports two PCI-E x1 or 1x4 expansion slots	supports PCI master and slave interface	six PCI slots	four PCI-E x1 connections, six PCI slots
IDE Support	N/A	two ATA/133 ports	parallel ATA/133 (up to four devices)	parallel ATA/133 (up to four devices)
SATA	N/A	up to four ports AHCI based SATA II 3Gbps with NCQ	support for two dual-channel SATA devices, SATA Lite interface for two additional SATA devices (four total)	support for two dual-channel SATA devices, SATA Lite interface for two additional SATA devices (four total)
USB	N/A	one EHCI USB 2.0 and three OHCI USB 1.1 ports, supporting up to eight USB ports	eight USB ports	eight USB 2.0 ports
Audio	N/A	HD Audio	VIA Vinyl 6-channel Audio (AC '97 integrated), VIA Vinyl Gold 8-channel Audio (PCI companion controller)	VIA Vinyl 6-channel Audio (AC '97 integrated), VIA Vinyl Gold 8-channel Audio (PCI companion controller)
Network Support	N/A	10/100 802.3x MAC, soft-modem interface	VIA Velocity GbE (PCI companion controller), VIA integrated 10/100 Fast Ethernet, MC '97 modem	VIA Velocity GbE (PCI companion controller), VIA integrated 10/100 Fast Ethernet, MC '97 modem
Storage Technology	N/A	RAID 0, 1, 0+1, 5, JBOD	RAID 0, 1, 0+1, JBOD (SATA)	RAID 0, 1, 0+1, JBOD (SATA)

Mobo Sampler

36 Enthusiast Motherboards From 18 Manufacturers

ABIT FATAL1TY AN8 SLI

The Fatal1ty version of the AN8 didn't make the previous Mobo Sampler (see *PC Modder* 2.0), but the Fatal1ty AN8 SLI is more than a simple revision. This socket 939 motherboard features NVIDIA's nForce4 SLI chipset and works with Athlon 64, Athlon 64 FX, and X2 dual-core processors. ABIT installed four 184-pin DIMM slots for up to 4GB of DDR400 SDRAM. Two PCI Express x16 slots promise to fulfill your graphic desires, operating at a full 16 pipelines when in single-card mode and eight pipelines each in dual-card mode. ABIT also included two legacy PCI slots and two PCI-E x1 slots.

Internal ports accommodate up to four 3Gbps SATA hard drives, which you can configure in RAID 0, 1, and 0+1 arrays. Up to four

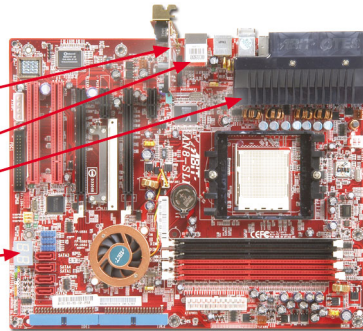
IDE devices can plug into the two onboard ports, while the floppy connector can handle two 1.44MB floppy drives. The rear I/O panel features four USB 2.0 ports, and onboard headers accommodate an additional six ports. An integrated FireWire controller manages an onboard header and a rear I/O panel port for two 400Mbps devices. ▲

AUDIOMAX CARD

GIGABIT ETHERNET

DUAL OTES

POST CODE DISPLAY



ABIT Fatal1ty AN8 SLI

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	Athlon 64, Athlon 64 FX, X2 dual-core
RAM Support	4GB DDR400/333
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	2
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	1 FireWire 400, plus 1 optional
LAN	Gigabit Ethernet
Integrated Audio	8-channel AudioMax, SPDIF
Integrated Graphics	N/A
Other features	Dual OTES, Guru LCD display
URL	www.abit-usa.com
Price	\$210

ABIT FATAL1TY NI8 SLI

With the Fatal1ty NI8 SLI, Johnathan "Fatal1ty" Wendel and ABIT set out to bring NVIDIA's SLI technology to the Intel crowd of enthusiasts. This second generation of Fatal1ty motherboards feels right at home with a slew of LGA 775 Hyper-Threading-enabled Pentium 4 processors. This board also supports a 1,066MHz frontside bus. Up to 4GB of DDR2 memory will fit into the four 240-pin DIMM slots, operating at 667MHz, 533MHz, and 400MHz speeds. The 16-pipeline graphics bus can handle one or two PCI-E graphics cards with the two onboard connectors. Two more x1 PCI-E slots are available for your peripherals, while ABIT retained two legacy PCI slots for your older cards.

You can connect up to four USB devices using the rear I/O panel ports, but four more are available via internal headers. The

rear I/O panel sports one FireWire 400 port, but you can install two more FireWire 400 devices with the internal headers. An NVIDIA Gigabit Ethernet controller delivers high-speed networking. NVIDIA also handles this board's RAID (0/1/0+1) for up to four 3Gbps SATA drives. ABIT's AudioMAX card provides eight channels of high-definition audio.

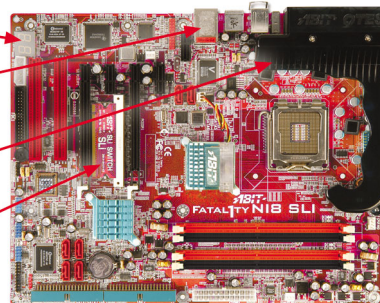
Like the AMD Fatal1ty AN8 SLI, this board features the OTES to help reduce overall system temperatures. ▲

POST CODE DISPLAY

GIGABIT ETHERNET

DUAL OTES

SLI SWITCH CARD



ABIT Fatal1ty NI8 SLI

Socket Type	LGA775 Intel
Chipset	NVIDIA nForce4 SLI
Processor Support	P4 with Hyper-Threading
RAM Support	4GB DDR2 667/533/400
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	2
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	1 FireWire 400, plus 2 optional
LAN	Gigabit Ethernet
Integrated Audio	8-channel AudioMax, SPDIF
Integrated Graphics	N/A
Other features	Dual OTES, Guru LCD display
URL	www.abit-usa.com
Price	\$190

ALBATRON K8SLI

The K8SLI is named for AMD's K8 (Athlon 64) platform and NVIDIA's nForce4 SLI chipset. The K8SLI supports both Athlon 64 and Athlon 64 FX processors. NVIDIA continues its reliance on the single-chip design for the nForce4 SLI. NVIDIA's latest chipset doesn't support DDR2, but you can get up to 4GB of DDR400/333 SDRAM into the four DIMM slots. Albatron included four PCI-E slots, two of which are x16 graphics slots, while the remaining two are x1 slots. The K8SLI also boasts two PCI slots for your legacy expansion cards.

This board features an integrated Vitesse VSC8201RX LAN controller, which delivers Gigabit Ethernet networking. Despite the new technologies packed onto this board, Albatron opted for Realtek's 6-channel ALC655 audio chip, rather than the 8-channel ALC880 or ALC882 chips that most enthusiast boards

feature. Eight USB 2.0 ports are available between the internal headers and the back I/O panel, but Albatron left out FireWire entirely. Four 3Gbps SATA ports can deliver RAID 0, 1, or 0+1 capabilities to as many drives. Two IDE ports are capable of supporting four devices at up to 133MBps speeds.

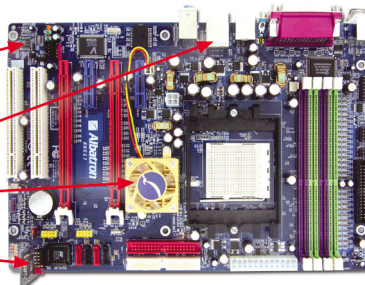
The motherboard also includes the ABS (Albatron BIOS Security) card, which is a spare BIOS chip that kicks in if the primary chip bites the dust. ▲

REALTEK
6-CHANNEL AUDIO

GIGABIT ETHERNET

NVIDIA NFORCE4 SLI

ABS CARD



Albatron K8SLI	
Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	Athlon 64, Athlon 64 FX
RAM Support	4GB DDR400/333
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	2
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	N/A
LAN	Gigabit Ethernet
Integrated Audio	Realtek ALC655 6-channel AC'97 CODEC
Integrated Graphics	N/A
Other features	Dual BIOS ABS Card, Hardware Monitor
URL	www.albatron.com.tw
Price	\$139

ALBATRON PX925X Pro-R

Albatron's enthusiast board for those particular to Intel comes in the form of the PX925X Pro-R. Intel's 925X northbridge supplies this board's 800MHz FSB, and accommodates LGA 775 Pentium 4 CPUs. Four DDR2 533/400 SDRAM DIMMs can populate the PX925X's four slots for as much as 4GB of memory in single- or dual-channel configurations. Intel's ICH6R southbridge manages the board's four SATA channels for up to four devices and 1.5Gbps of throughput. You can also build RAID 0, 1, and 0+1 arrays using SATA drives.

Albatron took the available PCI-E pipelines and divvied them up between two PCI-E x1 slots and one x16 slot for your PCI-E graphics card. Three PCI slots can handle any PCI expansion cards you may be hanging on to. As with the AMD-compatible K8SLI, this motherboard lacks FireWire

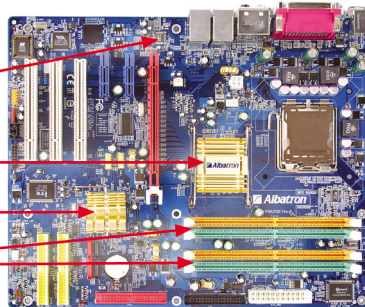
support. You can connect up to eight USB 2.0 devices using the four rear I/O panel ports and two internal headers. This motherboard's two RJ45 ports on the back panel provide simultaneous Gigabit Ethernet and 10/100 Ethernet networking. High-definition 8-channel audio comes courtesy of a Realtek ALC880 chip. ▲

REALTEK
8-CHANNEL AUDIO

INTEL 925X

INTEL ICH6R

DDR2



Albatron PX925X Pro-R	
Socket Type	LGA775 Intel
Chipset	Intel 925X, ICH6R
Processor Support	P4 with Hyper-Threading
RAM Support	4GB DDR2 533/400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (1.5Gbps RAID 0/1/0+1)
IDE	Ultra DMA 133/100
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	N/A
LAN	10/100, Gigabit
Integrated Audio	8-channel HD Audio
Integrated Graphics	N/A
Other features	Dual Ethernet, Hardware Monitor
URL	www.albatron.com.tw
Price	\$159

AOPEN I915GMm-HFS

AOpen is gunning for the enthusiasts' living room with the micro ATX i915GMm-HFS. This board features Intel's 915GM northbridge, which works with 479-pin Pentium M processors. The 533MHz FSB communicates with up to 2GB of DDR or DDR2 memory. The i915GMm-HFS' two 184-pin DIMM slots can handle DDR333 memory, while the two 240-pin DIMM slots use DDR2 533/400 memory. Intel's GMA (Graphics Media Accelerator) 900 won't satisfy most enthusiasts, but AOpen included an x16 PCI-E slot for a standalone graphics card. AOpen only had enough room for two PCI slots and one more PCI-E x1 slot, due to this board's limited form factor.

The ICH6-M southbridge, along with a Silicon Image controller, supports up to four 3Gbps SATA devices, configurable in RAID 0 and RAID 1 arrays. Dual

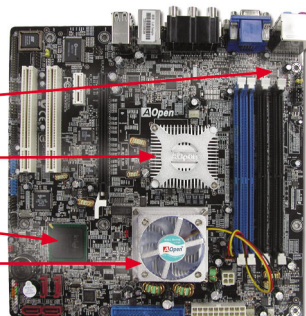
LAN controllers let you transfer data to and from this system at Gigabit-per-second speeds. The DVI output on the rear I/O panel delivers superior image quality, while the component plugs deliver 1080i and 720p high-definition resolution. 8-channel Azalia-compliant audio comes courtesy of an integrated Realtek ALC880 chip. AOpen also included SPDIF in and out ports. Between the rear I/O panel and internal headers, you can connect eight USB 2.0 devices and two FireWire 400 devices. ▲

REALTEK
8-CHANNEL AUDIO

INTEL 915GM

INTEL ICH6M

479-PIN CPU SOCKET



AOpen i915GMm-HFS

Socket Type	Socket 479
Chipset	Intel 915GM, ICH6-M
Processor Support	Pentium M (Dothan)
RAM Support	2GB DDR333, DDR2-533/400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	2
PCI-E Slots	1 PCI-E x1 slots
SATA Ports	4 (3Gbps RAID 0/1)
IDE	Ultra DMA 100
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	2 FireWire 400 (optional)
LAN	10/100/1000 Ethernet
Integrated Audio	Realtek ALC880 8-channel Azalia Audio
Integrated Graphics	Intel Graphics Accelerator 900
Other features	AOconfig, EzSkin, EzWinFlash
URL	usa.aopen.com
Price	N/A

AOPEN NCK804A-LFS

For the AMD enthusiasts, AOpen offers the nCK804a-LFS with the non-SLI NVIDIA nForce4 chipset. AOpen equipped the single-chip nForce4 with an active heatsink and fan assembly, which will add to the system's overall noise output, but can help to circulate warm air away from the board. This motherboard features a 939-pin CPU socket for Athlon 64 and Athlon 64 FX processors. The four onboard DIMM slots can handle up to 4GB of DDR400 or DDR333 memory in dual- or single-channel configurations. The integrated IDE controller can handle up to four devices for 133MBps of throughput per device. AOpen included three PCI Express slots, consisting of one x16 slot for a standalone graphics card and two x1 slots for PCI-E expansion cards. Three PCI slots manage your legacy peripherals.

Although graphics are up to you, this board's integrated audio

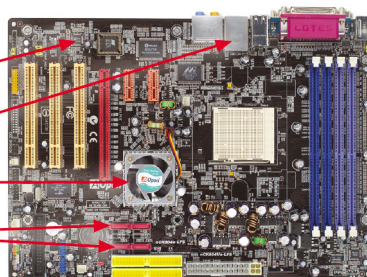
delivers 8-channel surround sound with an AC'97-compliant codec. Two FireWire 400 ports are available via two internal headers, while four USB 2.0 ports connect to the two internal headers. The rear I/O panel also sports an additional six USB 2.0 ports. NVIDIA's LAN controller and Marvell's physical chip provide the nCK804a-LFS with Gigabit Ethernet networking. A 4-channel SATA controller supports four 1.5Gbps SATA devices in RAID 0, 1, and 0+1 arrays. ▲

REALTEK
8-CHANNEL AUDIO

GIGABIT ETHERNET

NVIDIA NFORCE4

SATA RAID



AOpen nCK804a-LFS

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4
Processor Support	Athlon 64, Athlon 64 FX
RAM Support	4GB DDR400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (1.5Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	6, plus 4 optional (2.0)
FireWire Ports	2 FireWire 400 (optional)
LAN	Gigabit Ethernet
Integrated Audio	ACL-880 8-channel (AC'97 CODEC)
Integrated Graphics	N/A
Other features	AOconfig, EzSkin, EzWinFlash
URL	usa.aopen.com
Price	N/A

ASUS A8N-SLI PREMIUM

Following the success of the A8N SLI Deluxe, ASUS released the A8N SLI Premium, complete with a new passive cooling system called AI Cool-Pipe. The board accepts Athlon 64, Athlon 64 FX, and X2 dual-core processors. This board's HyperTransport bus is capable of up to 2,000MT/s (MegaTransfers per second). ASUS lets you load the A8N with as much as 4GB of DDR400/333/266 SDRAM. Matched modules can also run in dual-channel mode. Two x16 PCI-E slots let you double your graphical pleasure, while another x1 slot and x4 slot accommodate your peripherals. ASUS also included three PCI slots for older hardware.

Silicon Image manages four 1.5Gbps SATA channels, while NVIDIA offers an additional four for 3Gbps devices. The two controllers let you span RAID 0, 1, 5, 0+1, and JBOD arrays across both

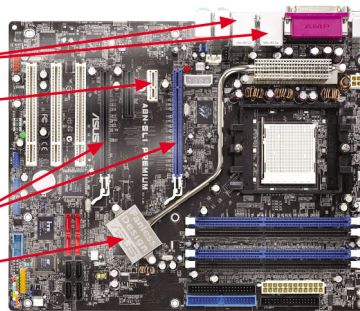
SATA and PATA devices. The rear I/O panel features four USB 2.0 ports and one FireWire 400 port. Internal headers account for an additional six USB 2.0 ports and one more FireWire 400 port. Dual LAN controllers for Marvell offer 10/100/1000 networking speeds between the two rear-panel RJ45 ports. The Realtek ALC850 controller provides the A8N with high-definition 8-channel surround sound audio. ▲

DUAL GIGABIT LAN

EZ-PLUG

DUAL PCI-E X16 SLOTS

NVIDIA NFORCE4 SLI



ASUS A8N-SLI Premium

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	Athlon 64, Athlon 64 FX, Athlon 64 X2
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	1 PCI-E x1 slot, 1 PCI-E x4 slot
SATA Ports	4 (1.5Gbps); 4 (3Gbps); (RAID 0/1/0+1/5/JBOD)
IDE	Ultra DMA 133/100
USB Ports	4, plus 6 more optional
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Dual Gigabit
Integrated Audio	Realtek ALC850 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	AI Cool-Pipe, AI Selector, EZ Plug
URL	www.asus.com
Price	N/A

ASUS P5WD2 PREMIUM

The P5WD2 Premium is ASUS' enthusiast board for Intel fans. ASUS strapped Intel's new 955X chipset onto the P5WD2's black PCB. The LGA 775 CPU socket can handle Pentium 4 processors with Hyper-Threading and FSB speeds of 1,066MHz, 800MHz, and 533MHz. Intel has throttled the 955X northbridge chip to accept DDR2 speeds up to 800MHz. Up to 8GB of memory can fill the four available 240-pin DIMM slots. Add dual-channel capabilities between matched modules and you've got the ultimate media-encoding motherboard. You can plug a graphics card into the onboard PCI-E x16 slot. ASUS also included an x1 PCI-E slot and an x4 "universal" PCI-E slot for peripherals.

Three IDE ports support two devices each with speeds up to 133MBps. A 4-channel SATA controller manages up to four 3Gbps SATA drives in RAID 0, 1, 0+1, and 5 arrays. Marvell and

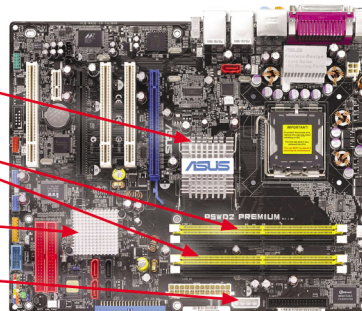
Intel deliver Gigabit Ethernet networking from each of the two RJ45 ports on the rear I/O panel. The P5WD2's rear I/O panel sports four USB 2.0 ports, one FireWire 400 port, and another 3Gbps SATA port. Internal headers accommodate an additional FireWire 400 port, and four more USB 2.0 ports. Realtek's high-end ALC882D chip delivers 8-channel surround sound for an immersive media experience. ▲

INTEL 955X

DDR2

INTEL ICH7R

EZ-PLUG



ASUS P5WD2 Premium

Socket Type	LGA 775 Intel
Chipset	Intel 955X, ICH7R
Processor Support	Pentium 4 with Hyper-Threading, P4 EE, Pentium D, Celeron
RAM Support	8GB DDR2 - 800/667/533
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	1 PCI-E x1 slot, 1 PCI-E x4 slot
SATA Ports	4 (3Gbps; RAID 0/1/0+1/5)
IDE	Ultra DMA 133/100
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Dual Gigabit
Integrated Audio	Realtek ALC882D 8-channel HD Audio
Integrated Graphics	N/A
Other features	AI NOS, CrashFree BIOS 2, AI Overclocking
URL	www.asus.com
Price	N/A

BIOSTAR N4SIE-A7

Biostar's enthusiast motherboard for Intel processors comes in the guise of the N4SIE-A7. This LGA 775 board features a 1,066MHz FSB, which works well with an array of Pentium 4 and Celeron CPUs. Unlike the AMD version, NVIDIA's nForce4 SLI chipset for Intel consists of a discrete northbridge and southbridge. The Intel version also features a memory controller, which manages up to 4GB of dual-channel DDR2 667/533 RAM between the four 240-pin DIMM slots. Like other SLI boards, the N4SIE-A7 features two PCI Express x16 slots, which operate at x8 when in dual-card mode. Biostar also included two x1 PCI-E slots and three PCI slots for your expansion cards.

The nForce4 MCP-SLI southbridge features a 4-channel SATA controller that lets you connect up to four 3Gbps drives using RAID 0, 1, and 0+1 configurations. The

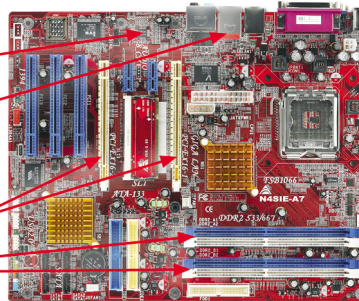
rear I/O panel features four USB 2.0 ports, while you can enable an additional six using the three onboard headers. A VIA VT6307 controller powers two FireWire 400 ports, one on the rear I/O panel and another from an onboard header. NVIDIA and Vitesse team up to provide the N4SIE-A7 with Gigabit Ethernet networking. Realtek's ALC850 controller delivers 8-channel surround sound for your games and DVDs. ▲

REALTEK
8-CHANNEL AUDIO

GIGABIT ETHERNET

DUAL PCI-E X16 SLOTS

DDR2



Biostar N4SIE-A7

Socket Type	LGA 775 Intel
Chipset	NVIDIA nForce4 SLI
Processor Support	Pentium 4 with Hyper-Threading
RAM Support	4GB DDR2-667/533
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Gigabit Ethernet
Integrated Audio	Realtek ALC850 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	WarpSpeeder, SLI-NF4 Selector
URL	www.biostar.com.tw
Price	\$169

BIOSTAR N4SLI-A9

The N4SLI-A9 is a socket 939 powerhouse designed for Athlon 64 and Athlon 64 FX processors. Biostar built this board around the NVIDIA nForce4 SLI chipset, which supports a full-duplex HyperTransport bus speed of 2,000MT/s. Until AMD updates the Athlon 64's integrated memory controller, the processors will only accommodate DDR400/333 SDRAM. You can populate this motherboard's four 184-pin DIMM slots with up to 4GB of memory in dual- or single-channel configurations. Two PCI-E x16 slots deliver up to 8GBps per direction of bandwidth (4GBps per card in dual-card mode). Biostar also made room on the N4SLI-A9's PCB for two more x1 PCI-E slots and three PCI slots.

NVIDIA's APU and the Realtek ALC850 audio chip join forces to provide 8-channel AC'97-compliant audio. A Vitesse VSC8201 LAN controller

manages the Gigabit Ethernet for the rear I/O panel's lone RJ45 port. NVIDIA's RAID technology delivers RAID 1 mirroring, RAID 0 striping, and the best of both, with RAID 0+1 on as many as four SATA devices. This board can handle plenty of peripherals between the eight USB 2.0 ports (four optional) and two FireWire 400 ports (one optional).

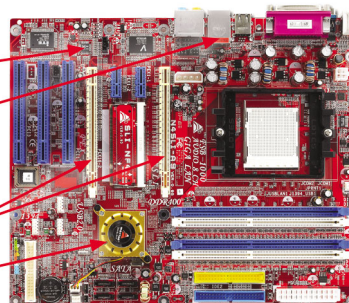
Enthusiasts will appreciate the WarpSpeeder utility, which features voltage and temperature monitoring as well as overclocking assistance. ▲

REALTEK
8-CHANNEL AUDIO

GIGABIT ETHERNET

DUAL PCI-E X16 SLOTS

NVIDIA NFORCE4 SLI



Biostar N4SLI-A9

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	Athlon 64 FX & Athlon 64
RAM Support	4GB DDR400
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 4 more optional
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Gigabit Ethernet
Integrated Audio	Realtek ALC850 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	WarpSpeeder, SLI-NF4 Selector
URL	www.biostar.com.tw
Price	\$129

CHAINTECH V915P

The V915P doesn't have a lot of the extras that enthusiasts look for, but this Intel board is priced well below most enthusiast boards. The V915P is a socket T (LGA775) motherboard built for Pentium 4 processors with Hyper-Threading and supports FSB speeds up to 800MHz. If you're not ready to toss your DDR memory, then this may be the board for you, with four 184-pin DIMM slots capable of handling a maximum of 4GB of 400MHz or 333MHz memory.

One 2-channel IDE port allows for two 100/66/33 devices, while the ICH6 southbridge manages up to four SATA devices operating at up to 1.5Gbps. The ICH6 southbridge doesn't support RAID, however.

Chaintech provides a single x16 PCI Express graphics slot for your video pleasure. Another two PCI-E x1 slots are directly adjacent to the video card slot.

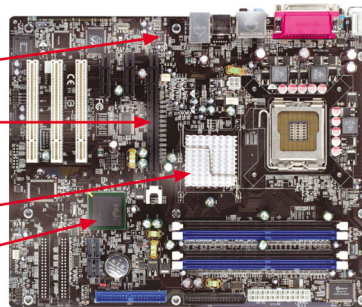
Chaintech included three PCI slots for your legacy expansion cards. If you're looking for FireWire, look elsewhere; Chaintech saw fit to exclude it from the V915P's PCB. The rear I/O panel features four USB 2.0 ports, but you have access to four more via internal headers. A Marvell 88E8001 LAN chip manages the board's Gigabit Ethernet. High-definition audio comes courtesy of Realtek's ALC880 chip, which delivers 8-channel surround sound. ▲

REALTEK
8-CHANNEL AUDIO

PCI-EXPRESS X16 SLOT

INTEL 915P

INTEL ICH6



Chaintech V915P

Socket Type	LGA 775 Intel
Chipset	Intel 915P, ICH6
Processor Support	Pentium 4 with Hyper-Threading
RAM Support	4GB DDR400/333
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (1.5Gbps)
IDE	Ultra DMA 100/66/33
USB Ports	4, plus 4 more optional
FireWire Ports	N/A
LAN	Gigabit Ethernet
Integrated Audio	ALC880 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	temperature monitor, fan speed monitor
URL	www.chaintechusa.com
Price	\$99.99

CHAINTECH VNF4 ULTRA ZENITH VE

The enthusiast Chaintech board for AMD-based processors is the VNF4 Ultra ZENITH VE. This board accepts socket 939 Athlon 64 and Athlon 64 FX processors and supports a 2000MTps HyperTransport bus. This NVIDIA nForce4 Ultra-equipped motherboard can handle up to 4GB of DDR400/333/266 memory in the four 184-pin DIMM slots. You can install various peripherals and add-ons with the board's three PCI slots and two PCI-E x1 slots. Chaintech reserved 16 PCI-E pipelines for the lone graphics card slot.

NVIDIA's single-chip nForce4 Ultra also juggles four SATA ports at 3Gbps of throughput per port. You can also configure multiple drives as RAID 0, 1, and 0+1 arrays. The VNF4 Ultra ZENITH VE supports two UltraDMA133/100/66 IDE devices. Vitesse provides the board's physical Gigabit Ethernet

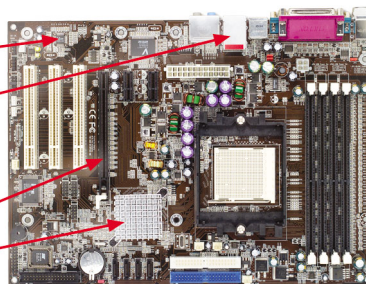
LAN adapter, while NVIDIA's ActiveArmor engine offloads the CPU and improves networking security. Realtek's ALC850 controller enables the coaxial SPDIF output and delivers 7.1 surround sound audio. You should have no trouble finding a home for your peripherals on the VNF4 Ultra ZENITH VE; it features four USB 2.0 ports on the rear I/O panel, with an additional six available from onboard headers. Chaintech decided to leave FireWire off of this board, as well. ▲

REALTEK
8-CHANNEL AUDIO

GIGABIT ETHERNET

PCI-EXPRESS X16 SLOT

NVIDIA NFORCE4



Chaintech VNF4 Ultra ZENITH VE

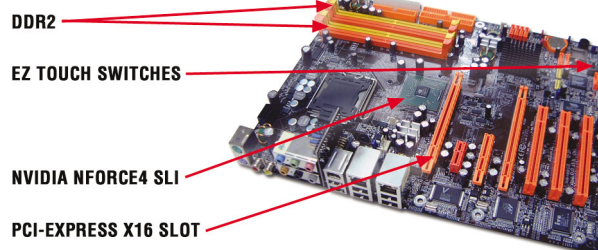
Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 Ultra
Processor Support	Athlon 64 FX & Athlon 64
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	1 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 6 more optional
FireWire Ports	N/A
LAN	Gigabit Ethernet
Integrated Audio	Realtek ALC850 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	NVIDIA ActiveArmor, Hardware Monitor
URL	www.chaintechusa.com
Price	\$89.99

DFI LANPARTY nF3 ULTRA-D

DFI chose to showcase the LANPARTY nF3 Ultra-D as its enthusiast motherboard for AMD processors. This socket 939 board has been on the shelf for a while and features NVIDIA's nForce3 Ultra chipset. Despite its age, the nF3 Ultra-D supports a 2,000MT/s HyperTransport bus speed with Athlon 64 and Athlon 64 FX processors. DFI's Web site states that the nF3 Ultra-D also supports AMD's Sempron processors, though as we went to press, no socket 939 Semprons had been announced. The four 184-pin DIMM slots are capable of handling up to 4GB of DDR400/300/266 SDRAM in either dual- or single-channel configurations. This board also relies on the rapidly aging AGP technology for its graphics port. Despite this, most high-end AGP 8X cards can perform comparably to the current generation of PCI Express cards—and they're cheaper.

If you have plenty of legacy PCI devices, the LANPARTY nF3

Ultra-D is the board for you with five slots. Realtek's integrated audio chip supports 6-channel surround sound and includes two RCA SPDIF jacks. The rear I/O panel sports four USB 2.0 ports, one FireWire 400 port, as well as parallel and serial ports. You also have access to four more USB 2.0 ports and one more FireWire 400 port via internal headers. A Gigabit Ethernet LAN controller provides all the bandwidth you'll need for lag-free online gaming and more. Marvell and NVIDIA offer RAID 0, 1, 0+1, and JBOD between up to four 1.5Gbps SATA drives. ▲



DFI LANPARTY UT nF3 ULTRA-D	
Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce3 Ultra
Processor Support	Athlon 64 FX & Athlon 64
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	AGP 8X/4X
PCI Slots	5
PCI-E Slots	N/A
SATA Ports	4 (1.5Gbps; RAID 0/1/0+1/JBOD)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 4 more optional
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Gigabit Ethernet
Integrated Audio	6-channel AC'97 CODEC, SPDIF
Integrated Graphics	N/A
Other features	NVIDIA nTune, CMOS Reloaded
URL	www.dfi.com.tw
Price	N/A

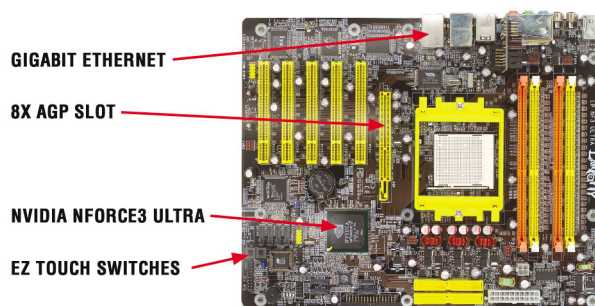
DFI LANPARTY UT NF4I SLI-T2R

Enthusiasts are quite familiar with DFI's award-winning LANPARTY UT series of motherboards, and the NF4I SLI-T2R is a worthy addition. This socket 775 motherboard boasts a 1,066MHz FSB, which works with Intel's Pentium 4 Hyper-Threading-enabled processors. NVIDIA's nForce4 (Intel Edition) northbridge lets you load this board's four 240-pin DIMM slots with up to 4GB of DDR2-667/533/400 SDRAM. You can also use matched modules for a dual-channel performance boost. The NF4I SLI-T2R has two PCI-E x16 slots for your favorite graphics card(s), one PCI-E x1, and one PCI-E x4 slot. DFI left three plain PCI slots to handle your legacy peripherals.

This motherboard comes with two SATA controllers that support RAID 0, 1, 0+1, 5, and JBOD arrays between as many as eight 3Gbps SATA devices. You can also use good old PATA devices with the RAID

arrays. A Karajan Audio Module snaps into place on the rear I/O panel to deliver 8-channel audio, while six USB 2.0 ports and one FireWire 400 port deliver instant Plug-and-Play connectivity. One more FireWire 400 port and four more USB 2.0 ports are optional. Vitesse and Marvell double up to deliver the board's Dual Gigabit Ethernet capabilities.

As with other LANPARTY motherboard offerings, the NF4I SLI-T2R features several UV-sensitive parts. ▲



DFI LANPARTY UT NF4I SLI-T2R	
Socket Type	LGA775 Intel
Chipset	NVIDIA nForce4 SLI
Processor Support	P4 with Hyper-Threading
RAM Support	4GB DDR2-667/533/400
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	1 PCI-E x1 slot, 1 PCI-E x4 slot
SATA Ports	8 (3Gbps; RAID 0/1/0+1/5/JBOD)
IDE	Ultra DMA 133/100
USB Ports	6, plus 4 optional (2.0)
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Dual Gigabit
Integrated Audio	8-channel AudioMax, SPDIF
Integrated Graphics	N/A
Other features	Karajan Audio Module, EZ Touch Switches
URL	www.dfi.com.tw
Price	\$130

ECS KN1 EXTREME

ECS, also known as Elitegroup, offers the KN1 Extreme as its premier AMD-based motherboard for enthusiasts. This rainbow-colored socket 939 board is built around NVIDIA's nForce4 Ultra chipset, which plays well with AMD's Athlon 64 and FX processors. The KN1 Extreme supports a 2000MT/s bus speed between the CPU and up to 4GB of DDR400/333/266/200 SDRAM. NVIDIA's Ultra chipset and the SiS 180 chip support up to six 133MBps IDE devices. Four 3Gbps SATA ports and two 1.5Gbps SATA ports accommodate up to six devices in RAID 0, 1, and 0+1 configurations.

The KN1 Extreme offers one PCI-E x16 slot for a video card and two more x1 slots for other PCI-E peripherals. Three PCI slots support a trio of expansion cards. Realtek and Marvell pull together to deliver Dual Gigabit Ethernet for high-speed online

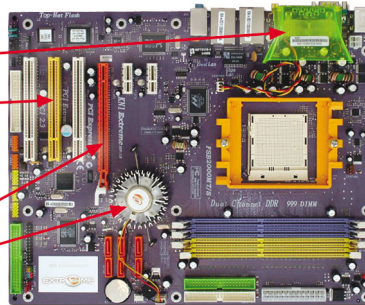
gaming. The rear I/O panel features four USB 2.0 ports, two SPDIF ports, a serial port, three audio jacks, and the Cooler Accelerator fansink. Two onboard headers support two optional FireWire 400 ports. The Realtek ALC655 audio controller offers 6-channel audio surround sound. ECS also installed a PCI Extreme slot between two plain PCI slots for better signal quality with audio and video expansion cards. ▲

COOLER ACCELERATOR

PCI EXTREME

PCI-EXPRESS X16 SLOT

NVIDIA NFORCE4



ECS KN1 Extreme

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 Ultra
Processor Support	Athlon 64 FX & Athlon 64
RAM Support	4GB DDR400/333/266/200
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps); 2 (1.5Gbps); (RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 6 more optional
FireWire Ports	2 optional FireWire 400
LAN	Dual Gigabit
Integrated Audio	Realtek ALC655 6-channel AC'97 CODEC, SPDIF
Integrated Graphics	N/A
Other features	Cooling Accelerator, Active Chipset Cooling
URL	www.ecsusa.com
Price	N/A

ECS PF88 EXTREME

Elitegroup's PF88 Extreme is an Intel socket 775 motherboard suffering from an identity crisis. Aside from Pentium 4 processors, the PF88 also accepts socket 479 Pentium M CPUs, Athlon 64/FX socket 939 CPUs, and Athlon 64/Sempron socket 754 CPUs. The PF88 is built around the SiS656 chipset, which links a 1,066MHz FSB to a 775 LGA socket. But if you aren't in a socket 775 mood, you can plug one of three daughter cards (sold separately) into the onboard EliteBus slot. Each daughter card consists of a processor socket, northbridge, DIMM slots, and a PWM (Pulse Width Modulation) module.

The PF88's native chipset can handle up to 4GB of DDR2-667 SDRAM in dual- or single-channel configurations. ECS made room on the board for two x16 PCI-E slots, one x1 PCI-E slot, and three more PCI slots. The SiS 965

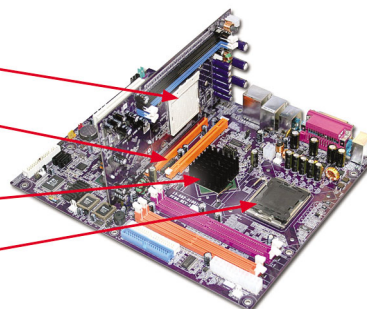
southbridge supports two IDE ports for four devices, plus two 3Gbps SATA ports. ECS wired a Silicon Image controller to an additional four 1.5Gbps SATA ports, which can be arrayed in RAID 0, 1, and 0+1 arrays. The board supports eight USB 2.0 ports (four optional) and two FireWire 400 ports (one optional). Other notable features include an integrated 8-channel audio controller, Gigabit Ethernet, a parallel port, and two serial ports. ▲

939-PIN SOCKET

ELITEBUS SLOT

SIS 656

LGA775 SOCKET



ECS PF88 Extreme

Socket Type	LGA 775 Intel, Socket 939 AMD
Chipset	SiS 656, 965
Processor Support	P4 with Hyper-Threading, Athlon 64, Athlon 64 FX
RAM Support	4GB DDR2-667/533, 2GB DDR400/333
RAM Slots	4 (plus 2 on S9A SIMA card)
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	1 PCI-E x1 slots
SATA Ports	4 (1.5Gbps); 2 (3Gbps); (RAID 0/1/0+1)
IDE	Ultra DMA 133/100
USB Ports	4, plus 4 more optional
FireWire Ports	1 FireWire 400 (plus 1 optional)
LAN	Gigabit Ethernet
Integrated Audio	8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	S9A SIMA Card, Dual-Channel Memory
URL	www.ecsusa.com
Price	N/A

EPoX EP-5NVA+ SLI

EPoX's enthusiast offering for Intel devotees is the EP-5NVA+ SLI. Strapped to NVIDIA's nForce4 SLI chipset, this motherboard supports Hyper-Threading from Intel's socket 775 Pentium 4 processors and a 1,066MHz FSB. Four 240-pin DIMM slots can handle up to 8GB of DDR2-667/533/400 system memory. Matched modules can also run in dual-channel mode for extra memory throughput. Two x16 PCI-E slots serve as home to your favorite PCI-E graphics card(s). In single-card mode, the PCI-E x16 slot operates at 16 pipelines, while each slot gets eight pipelines when in dual-card mode. Two PCI-E x1 slots and two PCI slots adorn the EP-5NVA+ SLI's green PCB.

NVIDIA's MCP04 southbridge handles four 3Gbps SATA drives in 0, 1, 0+1, and 5 arrays. The southbridge also enables as many as four 133MBps IDE devices among the two ports. The rear I/O panel sports four USB 2.0

ports, while internal headers deliver an additional six ports. Although the rear panel lacks FireWire ports, internal headers support up to two 400Mbps IEEE 1394 devices. An integrated Vitesse VSC8201RX controller delivers Gigabit Ethernet for ultra-fast online gaming and networking. Enthusiasts will also appreciate that EPoX installed Realtek's ALC850 8-channel audio controller.

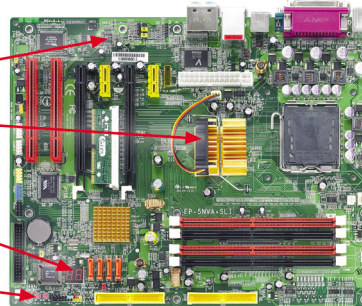
EPoX made sure to include the Post-Port LED display, which can be useful for diagnosing problems with the board. ▲

REALTEK
8-CHANNEL AUDIO

NVIDIA NFORCE4 SLI

LED DEBUG DISPLAY

EZ-BUTTONS



EPoX EP-5NVA+ SLI

Socket Type	LGA 775 Intel
Chipset	NVIDIA nForce4 SLI
Processor Support	Pentium 4 with Hyper-Threading
RAM Support	8GB DDR2-667/533/400
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	2
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/0+1/5)
IDE	Ultra DMA 133/100
USB Ports	4, plus 6 more optional
FireWire Ports	2 FireWire 400 (optional)
LAN	Gigabit Ethernet
Integrated Audio	Realtek ALC850 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	Onboard EZ-Button, Debug LED
URL	www.epox.com
Price	\$200

EPoX EP-9NPA+ SLI

The EP-9NPA+ SLI relies on NVIDIA's nForce4 SLI chipset for data communications. EPoX's enthusiast AMD board features a 2,000MT/s HyperTransport bus and a 939-pin socket for Athlon 64 and Athlon 64 FX CPUs. This motherboard supports up to 4GB of dual-channel memory, when you use matched modules, at speeds up to DDR400. As with other SLI boards, the EP-9NPA+ SLI shares the x16 PCI-E graphics bus between two slots. One more PCI-E x1 slot is directly adjacent to the primary x16 slot. EPoX also included three PCI slots for your legacy expansion cards.

NVIDIA's lone nForce4 SLI chip also handles the traditional southbridge functions, such as the IDE and SATA communications. The EP-9NPA+ SLI can handle up to four 133MBps IDE devices and four 3Gbps SATA devices, while a Silicon Image controller manages an additional two SATA devices. You can also

implement RAID 0, 1, and 0+1 arrays between both SATA and PATA devices. The Cicada CIS8201 LAN controller delivers Gigabit Ethernet networking. RealTek's ALC850 codec provides realistic 7.1 surround sound for your games and movies. The rear I/O panel features four USB 2.0 ports, two SPDIF ports, but no FireWire. You can connect two FireWire 400 ports to onboard headers, however.

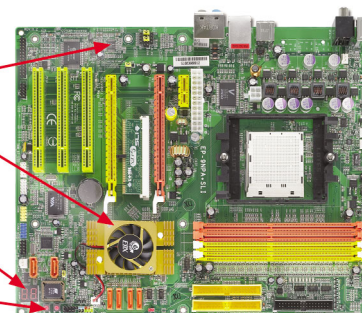
EPoX doesn't play favorites, though, and included the Post-Port LED display for advanced troubleshooting. ▲

REALTEK
8-CHANNEL AUDIO

NVIDIA NFORCE4 SLI

LED DEBUG DISPLAY

EZ-BUTTONS



EPoX EP-9NPA+ SLI

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	Athlon 64 FX & Athlon 64
RAM Support	4GB DDR400/333
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	1 PCI-E x1 slots
SATA Ports	6 (3Gbps; RAID 0/1/0+1)
IDE	Ultra DMA 133/100/66/33
USB Ports	4, plus 6 more optional
FireWire Ports	2 optional FireWire 400
LAN	Gigabit Ethernet
Integrated Audio	RealTek ALC850 8-channel HD Audio, SPDIF
Integrated Graphics	N/A
Other features	Debug LED, NVIDIA Active Armor
URL	www.epox.com
Price	\$145

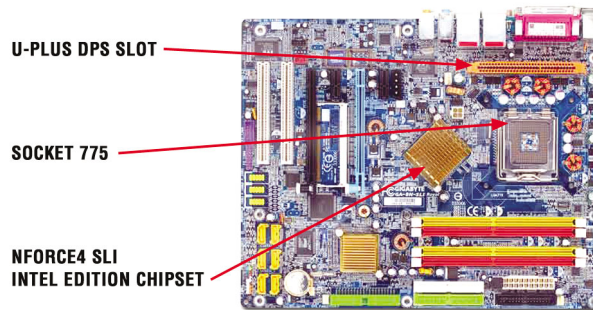
GIGABYTE GA-8N-SLI ROYAL

After AMD's CPUs received first crack at a chipset supporting dual graphics goodness, it was only a matter of time before NVIDIA rolled out a chipset that would let Intel enthusiasts do the same. The aptly named nForce4 SLI Intel Edition brings multirendering to Intel's Pentium D and Pentium 4 processors. The nForce4 chipset supports DDR RAM on AMD-based motherboards, but the nForce4 SLI Intel Edition supports DDR2 RAM (this shouldn't come as a surprise to Intel enthusiasts who have grown accustomed to DDR2). With support for a 1066MHz FSB and Intel's Extended Memory 64 Technology, this mobo is dressed to the nines.

RAID fanatics will likely fall in love with the GA-8N-SLI Royal. Not only does this board offer SATA bus bandwidth of up to 3Gbps and onboard RAID 5, but Hot Plug support lets you add

and remove SATA hard drives without shutting your PC down.

The GA-8N-SLI Royal sports all sorts of goodies Gigabyte devotees have come to love. In addition to features such as Gigabyte's DualBIOS, ShieldWare, EasyTune 5, and UPLUS DPS, the motherboard also comes with NVIDIA's Active Armor firewall (which teams up with Norton Internet Security to protect your system from online threats), integrated 8-channel audio, and support for IEEE 1394b. ▲



Gigabyte GA-8N-SLI Royal

Socket Type	Socket 775 Intel
Chipset	NVIDIA nForce4 SLI Intel Edition, MCP04
Processor Support	Intel Pentium D/Pentium 4
RAM Support	8GB DDR2-667/533
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	2
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	6 (3Gbps; RAID 0/1/0+1/5)
IDE	UDMA ATA 133/100/66
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	2 optional connectors for 3 ports (1394b)
LAN	Dual Gigabit Ethernet
Integrated Audio	8-channel ALC850, S/PDIF
Integrated Graphics	N/A
Other features	NVIDIA Active Armor, Gigabyte Dual BIOS, Gigabyte ShieldWare, U-PLUS D.P.S., EasyTune 5
URL	www.giga-byte.com
Price	N/A

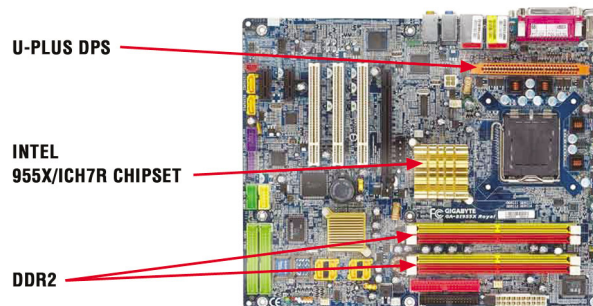
GIGABYTE GA-8I955X ROYAL

It doesn't take a math major to realize that Intel's 955X Northbridge, which supports dual-core Pentium D processors with Hyper-Threading technology, can simultaneously juggle up to four instruction threads. But what is perhaps more mind-blowing is the insane amount of ridiculously fast DDR2 RAM the GA-8I955X Royal will support. Its four DIMM slots are nothing to get riled up over, but consider that each slot can support up to 2GB of DDR-888 RAM when the FSB is set to run at 1,066MHz. Slap in an Intel Extreme Edition CPU with a Smithfield core and you're off to the races.

A PCI-E x16 slot for graphics and two PCI-E x1 slots shouldn't surprise anyone, but six 3Gbps SATA connectors make this motherboard an attractive choice for anyone with a handful of uber-fast SATA hard drives. There are also three IDE connectors if you just can't bear to recycle your old-school hard drives.

Dolby Master Studio is included with the GA-8I955X Royal; superior sound accompanies the board's support of Intel's cutting-edge hardware. Dolby Master Studio includes the following Dolby standards: Dolby Digital, Dolby Digital Live, Dolby Digital EX, Dolby Digital 5.1 Creator, Dolby Pro Logic IIx, Dolby Headphone, and Dolby Virtual Speaker.

Gigabyte's familiar faces—U-Plus DPS, Shieldware, DualBIOS, and Dual Gigabit Ethernet—all make their regularly scheduled appearances. ▲



Gigabyte GA-8I955X Royal

Socket Type	Socket 775 Intel
Chipset	Intel 955X, ICH7R
Processor Support	Intel Pentium D
RAM Support	8GB DDR2-888 (with 1066MHz FSB)/667/533/400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	6 (3Gbps; RAID 0/1/0+1/Matrix/JBOD)
IDE	UDMA ATA 133/100/66/33
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	3 optional (1394b)
LAN	Dual Gigabit Ethernet
Integrated Audio	8-channel ALC882, S/PDIF
Integrated Graphics	N/A
Other features	U-Plus D.P.S., Gigabyte DualBIOS, Gigabyte ShieldWare, Dolby Master Studio
URL	www.giga-byte.com
Price	N/A

INTEL D955XBK

At press time, the D955XBK was the Marshal on Intel's Stratego army. The Intel 955X Express chipset will support Socket 775 Intel Pentium D processors with an 800MHz FSB and Pentium 4 Extreme Edition processors with either an 800MHz or 1,066MHz FSB. You'll also find support for Intel's Extended Memory 64 Technology, which supports 64-bit computing.

Like Gigabyte's 955X-based motherboard, the D955XBK supports a mighty amount of RAM. The mobo's four DIMM slots will each hold a 2GB stick of DDR2-667 or DDR2-533 SDRAM (ECC or non-ECC).

Intel matched the D955XBK's ability to handle lots of fast DDR2 RAM, with 3Gbps RAID with NCQ (Native Command Queuing). There are four SATA connectors that offer 3Gbps bandwidth and, with the appropriate number of hard drives, RAID 0, 1, 5, and 10. Four more

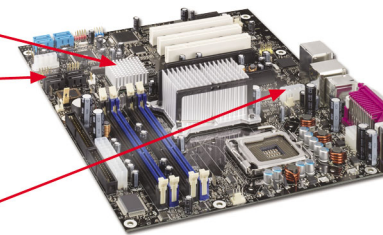
SATA connectors only have maximum bandwidth of 1.5Gbps and RAID 0, 1, and 10, but the ability to support up to eight SATA drives is nothing to sneeze at.

The D955XBK's rear I/O Panel will support almost any peripheral you can throw at it. There are four USB 2.0 ports and one IEEE 1394a port, and the D955XBK has pin headers to support an additional four USB 2.0 ports and two IEEE1394a/b ports. ▲

ICH7R SOUTHBRIDGE

SATA RAID

5V/12V MOLEX POWER CONNECTOR



Intel D955XBK	
Socket Type	Socket 775 Intel
Chipset	Intel 955XE, ICH7R
Processor Support	Pentium D, Pentium 4, Pentium EE
RAM Support	8GB DDR2-667/533
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	1 PCI-E x16/x4 slot, 1 PCI-E x1 slot
SATA Ports	4 (3Gbps; RAID 0/1/10/5/Intel Matrix RAID), 4 (1.5Gbps; RAID 0/1/10)
IDE	UDMA 33, ATA 100/66
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	1 (1394a), plus two optional (1394b/a)
LAN	Intel PRO 1000/100/100 LAN
Integrated Audio	8-channel Intel High-Definition Audio, S/PDIF
Integrated Graphics	N/A
Other features	Intel EMT64T support, Rapid BIOS Boot, Precision Cooling Technology
URL	www.intel.com
Price	\$245

INTEL D945PVS

Intel's D955XBK isn't the only Intel mobo to roll out the welcome mat for dual-core Pentium CPUs. But in addition to supporting Pentium D and Pentium 4 processors, the Intel D945PVS also makes Socket 775 Celeron D processors (with a 533MHz FSB) feel right at home. A big difference between the D955XBK and the D945PVS is that the D945PVS only supports up to 4GB of DDR2 RAM. On the other hand, the D945PVS has support for DDR2-400 in addition to DDR2-667/533.

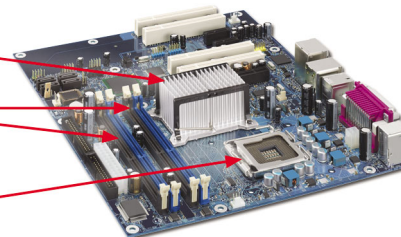
The four 1.5Gbps SATA ports on the D955XBK are absent on the D945PVS, but you'll still have the benefit of four 3Gbps SATA ports and RAID 0, 1, 5, 10, and Intel Matrix RAID. The D945PVS has a PCI-E x16 slot for graphics cards and two PCI x1 slots, but there are also four traditional PCI slots for older expansion cards that still use the PCI bus.

Intel's 8-channel audio subsystem offers five analog audio outputs and two S/PDIF digital audio outputs (coaxial and optical) using a Sigmatel 9223 audio codec. According to Intel, its Precision Cooling Technology manages fan speeds to strike an effective balance between adequate system temperature and lower noise levels. ▲

INTEL 945P NORTHBRIDGE

DDR2

SOCKET 775



Intel D945PVS	
Socket Type	Socket 775 Intel
Chipset	Intel 945P, ICH7R
Processor Support	Pentium D, Pentium 4, Celeron D
RAM Support	4GB DDR2-667/533/400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	4
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (3Gbps; RAID 0/1/10/5/Intel Matrix RAID)
IDE	UDMA 33, ATA 100/66
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	Up to 3 (1394a)
LAN	Intel PRO 1000/100/100 LAN
Integrated Audio	8-channel Intel High-Definition Audio, S/PDIF
Integrated Graphics	N/A
Other features	Intel EM64T support
URL	www.intel.com
Price	\$175

JETWAY 939GT4-SLI

Sure, manufacturers such as ASUS and MSI may have been among the first to stake out claims in SLI territory, but Jetway's 939GT4-SLI still deserves a serious look. In fact, a quick glance at the 939GT4-SLI's spec sheet reveals a motherboard that should be every bit as powerful as motherboards from Jetway's competitors.

With support for a 1,000MHz FSB and HyperTransport technology, the 939GT4-SLI will let you harness the processing power of some awfully mighty AMD Athlon 64 FX CPUs. Although most motherboards use two PCI-E x16 slots and a selector card to split the x16 graphics bus into two x8 lanes, Jetway's motherboard has one true PCI-E x16 slot for single card configurations and two PCI-E x16 slots that are preset to run two x8 lanes. As a result, the 939GT4-SLI's three PCI-E x16 slots give it a rather unique look.

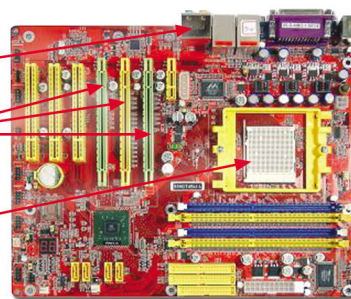
Four 3Gbps SATA connectors are ready to run a striped, mirrored, or striped and mirrored array, if you have enough hard drives, and the 939GT4-SLI's 8-channel onboard audio makes it competitive with a lot of stand-alone audio systems.

The Jetway 939GT4-SLI motherboard also has the following bonus software: IMAGE IT! System Backup software and ProMagic PLUS! System Recovery. ▲

S/PDIF

PCI-E X16 SLOTS

SOCKET 939



Jetway 939GT4-SLI

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	AMD Athlon 64/64 FX
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot; 2 PCI-E x8 slots
PCI Slots	3
PCI-E Slots	1 PCI-E x1 slot
SATA Ports	4 (3Gbps; RAID 0/1/ 0+1)
IDE	UDMA ATA 133
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	N/A
LAN	Gigabit Ethernet
Integrated Audio	8-channel AC97 codec
Integrated Graphics	N/A
Other features	IMAGE IT! System Backup Software, ProMagicPLUS! System Recovery, CPU Smart Fan Noise Restrained System
URL	www.jetway.com.tw
Price	N/A

JETWAY 754EXP-G-OC

If you like the idea of upgrading to a Socket 754 motherboard and want to upgrade your graphics card to one that uses PCI-E x16 architecture, Jetway's 754EXP-G-OC might be the motherboard you've been looking for. Based around VIA's K8T890 northbridge and VT8237 southbridge, the 754EXP-G-OC accepts 754-pin versions of AMD's Athlon 64 family of CPUs. Two DIMM slots support a maximum of 2GB DDR400/333/266 SDRAM.

Two 1.5Gbps SATA connectors don't make the 754EXP-G-OC the leader of the pack in terms of storage, but it will let you set up a RAID 0 or 1 array. There are four IDE connectors that support up to four IDE devices.

For those who demand a fast wired network, the 754EXP-G-OC sports an integrated Realtek 8100S Giga-LAN chip for a Gigabit Ethernet data transfer rate. If Gigabit Ethernet doesn't wind your clock, Jetway's 754EXP-G-OC

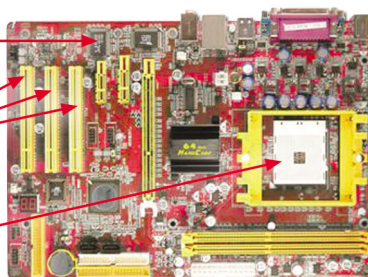
offers the same features as the 754EXP-G-OC but with a svelte VIA 6103L LAN PHY chip for 10/100 Fast Ethernet.

Overclockers should be pleased to know that the 754EXP-G-OC is quite flexible in terms of volt modding. You can adjust the CPU voltage over seven .05V increments to gradually give your CPU more juice until you've maximized its potential. ▲

8-CHANNEL AUDIO

3 PCI SLOTS

SOCKET 754



Jetway 754EXP-G-OC

Socket Type	Socket 754 AMD
Chipset	VIA K8T890, VT8237
Processor Support	Athlon 64
RAM Support	2GB DDR400/333/266
RAM Slots	2
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	2 (1.5Gbps; RAID 0/1)
IDE	UDMA ATA 133
USB Ports	8 (2.0)
FireWire Ports	N/A
LAN	Gigabit Ethernet
Integrated Audio	8-channel AC97 codec
Integrated Graphics	N/A
Other features	CPU Smart Fan Noise Restrained System, Bi-turbo function, 7-shift
URL	www.jetway.com.tw
Price	N/A

MSI K8N NEO4 PLATINUM/SLI

Last time around, MSI just missed the boat with the K8N Neo4 Platinum/SLI: It wasn't quite ready for the spotlight as we went to press, and we suspect the story is the same for any ATI CrossFire board the company might be cooking up. Either way, the K8N Neo4 Platinum is here now and is a solid motherboard for AMD enthusiasts looking to double their graphics and CPU cores. Not only does the K8N Neo4 Platinum/SLI support NVIDIA's SLI, it's also ready for dual-core AMD Athlon 64 X2 processors.

Because this is an SLI-capable motherboard, you'll find two PCI-E x16 slots ready for action. This motherboard uses a selector card instead of digital switching (see the P4N Diamond below) to alternate between single card and SLI mode.

The K8N Neo4 Platinum/SLI has 4 DIMM slots and supports up to 4GB DDR400/333/266 SDRAM.

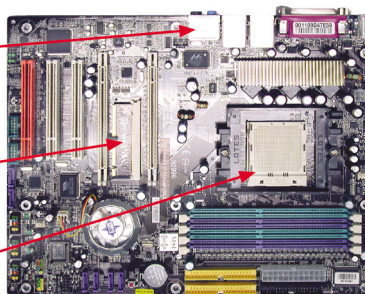
The nForce4 SLI chipset welcomes faster 3Gbps SATA drives, and this mobo offers RAID 0, 1, 0+1, and JBOD configurations.

Other powerful options abound with 10 USB 2.0 ports (four on the rear I/O panel, six via onboard pin headers); three IEEE 1394a ports (one on the rear I/O panel, two via onboard pin headers); Dual Gigabit Ethernet; and 8-channel audio, courtesy of a 24-bit Sound Blaster Live chip. ▲

8-CHANNEL AUDIO S/PDIF

SLI SELECTOR CARD

SOCKET 939 AMD



MSI K8N Neo4 Platinum/SLI

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 SLI
Processor Support	AMD Athlon 64/64X, X2
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	3
PCI-E Slots	N/A
SATA Ports	6 (3Gbps; RAID 0/1/0+1/JBOD)
IDE	UDMA 133/100/66
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	1, plus 2 optional (IEEE 1394a)
LAN	Dual Gigabit Ethernet
Integrated Audio	8-channel Sound Blaster Live 24-bit
Integrated Graphics	N/A
Other features	Live Update, Fuzzy Logic, PC Alert, MSI CoreCell, MSI CoreCenter, DigiCell
URL	www.msicomputer.com
Price	N/A

MSI P4N DIAMOND

With the P4N Diamond motherboard, MSI joins the ranks of motherboard manufacturers to offer SLI products for both AMD and Intel enthusiasts. Like our other stalwart Intel-based SLI mobos, the P4N Diamond centers around NVIDIA's nForce4 SLI Intel Edition chipset, which pairs with the NVIDIA MCP04 southbridge via a HyperTransport link. The P4N Diamond supports Socket 775 Intel Pentium 4, Pentium 4 Extreme Edition, Pentium D, Pentium XE, and Celeron D processors.

The P4N Diamond has four DIMM slots to support up to 4GB DDR2-667/533 SDRAM. SLI enthusiasts familiar with using a selector card might be surprised to see this common SLI component absent from the P4N Diamond. MSI used digital switching to alternate between single card and SLI mode.

Thanks to the MCP04, the P4N Diamond has onboard RAID 5

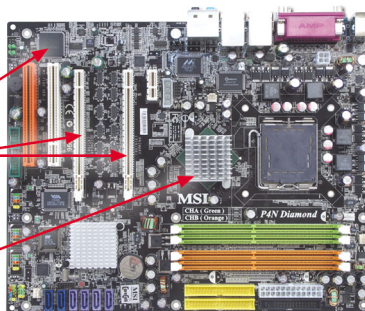
(and 0, 1, and 0+1) at its fingertips. NV RAID also supports SATA transfer rates of up to 3Gbps. There are four SATA connectors and two IDE connectors (ATA 133), so you can have a maximum of eight hard drives.

Creative Labs fans should be pleased to Sound Blaster Live 24-bit audio integrated into the P4N Diamond. With the onboard audio, you can experience 7.1-channel surround sound; S/PDIF is also included. ▲

8-CHANNEL SOUND BLASTER LIVE AUDIO

2 PCI-E X16 SLOTS

NVIDIA NFORCE4 SLI INTEL EDITION CHIPSET



MSI P4N Diamond

Socket Type	Socket 775 Intel
Chipset	NVIDIA nForce4 SLI Intel Edition
Processor Support	P4, P4EE, Pentium D, Pentium XE, Celeron D
RAM Support	4GB DDR2-667/533
RAM Slots	4
Graphics Bus	2 PCI-E x16 slots
PCI Slots	2
PCI-E Slots	1 PCI-E x1 slot
SATA Ports	6 (3Gbps; RAID 0/1/0+1/5/JBOD)
IDE	UDMA ATA 133/100/66
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	1, plus 2 optional
LAN	Dual Gigabit Ethernet
Integrated Audio	8-channel Sound Blaster Live 24-bit
Integrated Graphics	N/A
Other features	Live Update, CoreCell, CoreCenter, DigiCell
URL	www.msicomputer.com
Price	N/A

SOLTEK SL-NF4Pro-939

This Socket 939 motherboard is a great choice for anyone who wants to use NVIDIA's nForce4 chipset but doesn't need all that extraneous SLI mumbo jumbo. The SL-NF4Pro-939 supports AMD's Athlon 64/64 FX and Sempron processors and a 1GHz HyperTransport FSB. There are four DIMM slots that accept up to 4GB unbuffered, non-ECC DDR400/333 SDRAM. It also supports dual-channel memory.

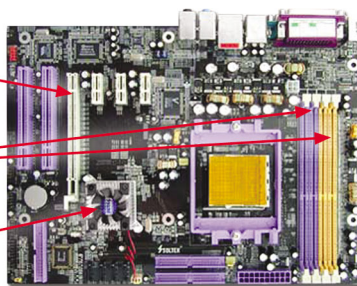
The SL-NF4Pro-939 uses a PCI-E x16 graphics bus. For expansion cards, it has three PCI-E x1 slots and two PCI slots. There are also plenty of ports for a multitude of peripheral devices. Four USB 2.0 ports and an IEEE 1394 port find their home on the SL-NF4Pro-939, and pin headers on the motherboard let you add six more USB 2.0 ports and an extra IEEE 1394 port.

Two IDE connectors (ATA 133/100/66) and four 1.5Gbps SATA connectors will provide you with plenty of ways to set up a RAID, if you have the right number of hard drives. NV RAID supports RAID 0, 1, 0+1 configurations, regardless of what interface your hard drives use.

Soltek's RedStorm2 Overclocking Technology is an optional feature, but it should help novice overclockers push their hardware without risking damaging any of it too much. ▲

PCI-E X16 SLOT

DDR

NVIDIA
NFORCE4 CHIPSET

Soltek SL-NF4Pro-939

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4
Processor Support	Athlon 64/64 FX, Sempron
RAM Support	4GB DDR 400/333
RAM Slots	4
Graphics Bus	1 PCI x16 slot
PCI Slots	2
PCI-E Slots	3 PCI-E x1 slots
SATA Ports	4 (1.5Gbps; RAID 0/1/0+1)
IDE	ATA 133/100/66
USB Ports	4, plus 6 optional (2.0)
FireWire Ports	1, plus 1 optional
LAN	Gigabit Ethernet
Integrated Audio	8-channel ALC850 codec, S/PDIF
Integrated Graphics	N/A
Other features	RedStorm2 Overclocking
URL	www.soltek.com.tw
Price	N/A

SOLTEK SL-B5A-FGR

The SL-B5A-FGR is one of Soltek's Qbic motherboards, so one of its big selling points is its size. Measuring 180mm x 270mm, this motherboard's claim to fame is the fact that it's ideal for SFF computers. Based around Intel's 915G/ICH6R chipset, the SL-B5A-FGR can handle Socket 775 Pentium 4 or Celeron D CPUs with either an 800MHz or 533MHz FSB.

Because the motherboard has a smaller layout, there are only two DIMM slots. Although most motherboards that use a 915G northbridge require DDR2 RAM, the SL-B5A-FGR accepts up to 2GB of DDR400/333 SDRAM.

Because the SL-B5A-FGR has an integrated graphics chip, you can opt out of using a graphics card—a smart decision if you don't think you'll be playing a lot of recent games or using any other demanding 3D applications. But if you want the extra

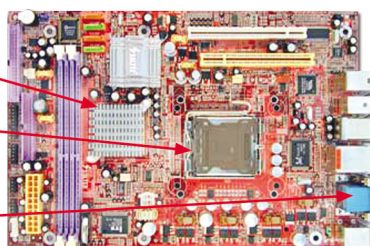
3D muscle a graphics card will undoubtedly give you, the SL-B5A-FGR has a PCI-E x16 slot to make compatible graphics cards feel right at home.

Intel's ICH6R southbridge and four SATA connectors will let you turn your SFF PC into a fierce RAID machine, letting you set up either a striped or mirrored array. Soltek's optional SmartDoc and RedStorm Overclocking Technology further sweeten the pot. ▲

INTEL
915G/ICH6R CHIPSET

SOCKET 775

VGA PORT



Soltek SL-B5A-FGR

Socket Type	Socket 775 Intel
Chipset	Intel 915G, ICH6R
Processor Support	P4, Celeron D
RAM Support	2GB DDR 400/333
RAM Slots	2
Graphics Bus	1 PCI-E x16 slot
PCI Slots	1
PCI-E Slots	0
SATA Ports	4 (1.5Gbps; RAID 0/1)
IDE	ATA 100/66
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	1 (1394a), plus 1 optional (1394a)
LAN	Gigabit Ethernet
Integrated Audio	8-channel AC'97 Audio
Integrated Graphics	Intel Graphics Media Accelerator 900
Other features	Red Storm Overclocking, SmartDoc, SAT (Smart Acceleration Technology)
URL	www.soltek.com.tw
Price	N/A

SOYO GROUP SY-P4I 845PE ISA

Soyo Group's SY-P4I 845PE ISA, which has been around for a while, is a Socket 478 motherboard that supports Pentium 4 and Celeron processors with a wide range of clock frequencies. Pentium 4 processors between 1.4GHz and 3.06GHz and Celeron processors 1.7GHz and 2.8GHz are compatible with the SY-P4I 845PE ISA, which supports either a 533MHz or 400MHz FSB. Two DIMM slots can each accept up to 1GB unbuffered, non-ECC DDR333/266 SDRAM. Soyo recommends Kingston RAM for this motherboard.

The AGP slot on the SY-P4I 845PE ISA can operate in either 2X or 4X mode with 1.5V AGP graphics cards. There are four PCI slots and three ISA slots for expansion slots, and two IDE connectors support a maximum of four IDE devices.

The SY-P4I 845PE ISA also takes care of your networking and audio needs. It has onboard 10/100 Fast Ethernet and an

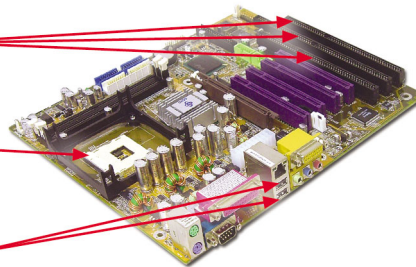
AC97 audio codec delivers 4-channel sound. The rear I/O panel has two USB 2.0 ports, and the motherboard has pin headers for four more USB 2.0 ports.

There are no SATA connectors or PCI Express slots on the SY-P4I 845PE ISA, but it can handle a smart card reader (sold separately). Extra features include onboard Hardware Monitoring and the Hardware Health Utility. ▲

3 ISA SLOTS

SOCKET 478

2 USB 2.0 PORTS



Soyo Group SY-P4I 845PE ISA

Socket Type	Socket 478 Intel
Chipset	Intel i845PE
Processor Support	P4 (1.7GHz-3.06GHz), Celeron (1.7GHz-2.8GHz)
RAM Support	2GB DDR333/266
RAM Slots	2
Graphics Bus	AGP 2X/4X
PCI Slots	4
PCI-E Slots	N/A
SATA Ports	N/A
IDE	UDMA 100/66
USB Ports	2, plus 4 optional (2.0)
FireWire Ports	N/A
LAN	10/100 Ethernet
Integrated Audio	4-channel AC97
Integrated Graphics	N/A
Other features	3 ISA slots, Hardware Health Utility
URL	www.soyousa.com
Price	\$174.99

SOYO GROUP SY-K8USA

Athlon 64 enthusiasts with a craving for extra goodies will probably like Soyo Group's SY-K8USA Dragon Ultra Black Label. A Socket 754 motherboard, the SY-K8USA uses ALI's M1687/1563 chipset and supports AMD Athlon 64 processors (2800+ to 3700+). The chipset supports a 400/800MHz FSB. Three DIMM slots can manage up to 2GB DDR400/333/266 SDRAM.

The SY-K8USA uses an AGP 8X graphics bus and has five PCI slots for your expansion cards. There are no PCI Express slots on the SY-K8USA.

Two SATA connectors let you connect two 1.5Gbps hard drives and set up a RAID 0 or 1 configuration. Three IDE connectors support a total of six IDE devices. One IDE channel is reserved for an optional RAID configuration.

There's also broad support for all of your peripheral devices. The SY-K8USA has four rear

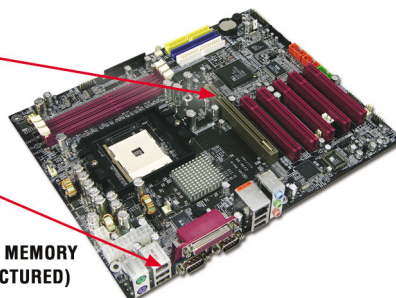
USB 2.0 ports and a rear IEEE 1394 port; you can use the pin headers to attach two more USB 2.0 and IEEE 1394 ports.

Although there's an FDD connector for a floppy disk drive, the included BayONE XP media card reader/writer is the real removable storage darling; SD, CF (both I and II), and Memory Stick PRO are among some of the types of media the BayONE XP can handle. ▲

AGP 8X SLOT

IEEE 1394

BAYONE XP 9-IN-1 FLASH MEMORY READER/WRI-TER (NOT PICTURED)



Soyo Group SY-K8USA Dragon Ultra

Socket Type	Socket 754 AMD
Chipset	ALI M1687, M1563
Processor Support	Athlon 64
RAM Support	2GB DDR400/333/266
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
PCI-E Slots	N/A
SATA Ports	2 (1.5Gbps; RAID 0/1)
IDE	UDMA ATA 133/100/66
USB Ports	4, plus 2 optional (2.0)
FireWire Ports	1, plus 2 optional
LAN	VIA Gigabit Ethernet
Integrated Audio	6-channel Cmedia CMI9739A codec, S/PDIF
Integrated Graphics	N/A
Other features	BayONE XP 9-in-1 Flash Memory Reader/Writer, Norton AntiVirus, Norton Ghost 2003, Norton Personal Firewall 2003
URL	www.soyousa.com
Price	\$199

SUPERMICRO PDSLA

Supermicro has gained quite a reputation for manufacturing quality server motherboards, but its desktop mobos are awfully impressive, too. The PDSLA is one example of a solid and flexible offering. It supports Pentium 4, Pentium 4 Extreme Edition, Pentium D, and Celeron D processors and has a few more surprises under the hood.

Because the “G” in Intel’s 945G chipset stands for graphics, the PDSLA lets you take two paths for your graphics. A PCI-E x16 slot lets you install today’s cutting-edge graphics cards, or you can use the motherboard’s integrated Intel Graphics Media Accelerator 950 video chip if you don’t require high-powered 3D graphics.

Like Intel’s D945PVS motherboard, the PDSLA supports DDR2-400 SDRAM in addition to faster DDR2-667 and DDR2-533. There are four DIMM slots, and the PDSLA supports 4GB RAM.

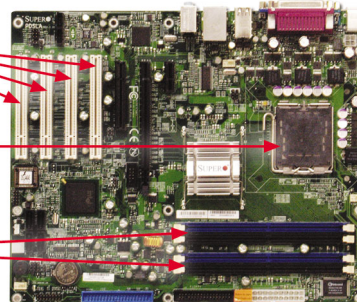
For expansion options, the PDSLA has four PCI slots and two PCI-E x1 lanes (the board has an x1 and x8 slot, but both let you use a single x1 lane). The rear I/O panel has six USB 2.0 ports, and there are pin headers for an additional two ports.

Because the PDSLA uses ICH7 southbridge instead of the ICH7R, it doesn’t support RAID configurations, but you can use faster 3Gbps SATA hard drives. The motherboard supports up to four hard drives. ▲

4 PCI SLOTS

SOCKET 775

DDR2



SuperMicro PDSLA

Socket Type	Socket 775 Intel
Chipset	Intel 945G, ICH7
Processor Support	P4, P4EE, Pentium D, Celeron D
RAM Support	4GB DDR2-667/533/400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	4
PCI-E Slots	2 PCI-E x1 (1 x1 slot, 1 x8 slot)
SATA Ports	4 (3Gbps)
IDE	UDMA ATA 100
USB Ports	6, plus 2 optional (2.0)
FireWire Ports	N/A
LAN	Intel 82573 Gigabit Ethernet
Integrated Audio	6-channel AC97 codec
Integrated Graphics	Intel Graphics Media Accelerator 950
Other features	Super Doctor III, Watch Dog, NMI, BIOS rescue hot keys
URL	www.supermicro.com
Price	\$174

SUPERMICRO PDG4

Supermicro’s PDG4 has a few traits that might make you think it’s a server motherboard, but it’s really geared toward being a high-end desktop mobo. Based around Intel’s 955X northbridge and ICH7R southbridge, the PDG4 accepts the following Intel CPUs: Pentium 4, Pentium 4 Extreme Edition, Pentium D, and Celeron D. Four DIMM slots each support a maximum 2GB DDR2-667/533/400 SDRAM, letting you cram as much as 8GB RAM onto the PDG4.

The PDG4 is one of the more flexible motherboards in our roundup, in terms of PCI expansion slots. In addition to a PCI-E x16 slot for graphics cards, the PDG4 boasts one PCI-E x1, two PCI-X, and three PCI slots.

Intel’s ICH7R southbridge gives you a few attractive storage options. You can use the PDG4’s four 3Gbps SATA

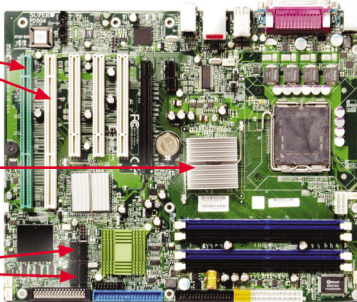
connectors to set up RAID 0, 1, 5, or 10 configurations. Anyone who owns a few ultra-fast SCSI hard drives is also in luck. An integrated Adaptec AIC-7901 controller provides single-channel Ultra320 SCSI RAID 0, 1, 10, and JBOD support.

The PDG4’s rear I/O shield has six USB 2.0 ports and an RJ45 port for Gigabit Ethernet (via Intel’s 82573V chip). There are also pin headers for an additional two USB 2.0 ports. ▲

2 PCI-X SLOTS

INTEL 955X/ICH7R CHIPSET

SATA RAID



SuperMicro PDG4

Socket Type	Socket 775 Intel
Chipset	Intel 955X, ICH7R
Processor Support	P4, P4 EE, Pentium D, Celeron D
RAM Support	8GB DDR2-667/533/400
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3 PCI, 2 PCI-X
PCI-E Slots	1 PCI-E x1 slot
SATA Ports	4 (3Gbps; RAID 0/1/5/10)
IDE	UDMA ATA 100/66
USB Ports	6, plus 2 optional (2.0)
FireWire Ports	N/A
LAN	Intel 82573V Gigabit Ethernet
Integrated Audio	6-channel AC97] codec
Integrated Graphics	N/A
Other features	Super Doctor III, Watch Dog, NMI, Adaptec AIC-7901 Single-Channel Ultra320 SCSI controller (RAID 0, 1, 10, JBOD)
URL	www.supermicro.com
Price	\$333

TUL AX480A-GF

With Tul's AMD-based motherboards, ATI enters the chipset rumble along with established veterans such as Intel, VIA, NVIDIA, and SiS. The Tul AX480A-GF, which uses ATI's Radeon Xpress 200P/SB400 chipset, supports Socket 939 AMD Athlon 64/64FX processors. As much as 4GB DDR400/333/266 memory can settle down and make a home for itself in the AX480A-GF's four DIMM slots, which also support dual-channel technology.

Next-gen 3Gbps SATA hard drives won't do you much good, but the AX480A-GF lets you set up 1.5Gbps SATA drives in a striped or mirrored array. There are also two IDE connectors that accept up to four UDMA ATA 133 IDE devices, and if you really want to show off your dual floppy drive rig, the AX480A-GF FDD connectors supports two floppy disk drives.

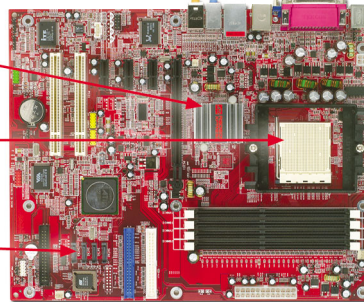
The AX480A-GF uses a PCI-E x16 as its graphics bus and has two PCI and three PCI-E x1 slots for expansion cards. Four USB 2.0 ports and an IEEE 1394 port make an appearance on the motherboard's rear I/O panel, and you can add four more USB 2.0 ports and an additional IEEE 1394 port via pin headers on the motherboard itself.

Integrated 8-channel audio with S/PDIF ports and Gigabit Ethernet are two other highlights of the AX480A-GF. ▲

ATI RADEON XPRESS
200P/ATI SB400 CHIPSET

SOCKET 939

SATA RAID



Tul AX480A-GF

Socket Type	Socket 939 AMD
Chipset	ATI Radeon Xpress 200P, ATI SB400
Processor Support	Athlon 64/64 FX
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	1 PCI-E x16 slot
PCI Slots	2
PCI-E Slots	3 PCI-E x1 slots
SATA Ports	4 (1.5Gbps; RAID 0/1)
IDE	UDMA ATA 133
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	1, plus 1 optional
LAN	Gigabit Ethernet
Integrated Audio	8-channel Realtek ALC850 codec, S/PDIF
Integrated Graphics	N/A
Other features	N/A
URL	www.tul.com.tw
Price	N/A

TUL A480A7-VGF

Tul's A480A7-VGF is an ATI chipset-based answer to motherboards that use Intel chipsets such as the 915G or 945G. An ATI Radeon X300 series core supplies the integrated graphics horsepower to the A480A7-VGF, if you don't feel like scrounging up a separate graphics card. The Radeon Xpress 200/ULI M1573 chipset supports Socket 754 AMD Athlon 64 processors with up to a 1,600MT/s HyperTransport system bus. There are two DIMM slots for up to 2GB DDR400/333/266 RAM.

The Radeon X300 series core should be sufficient for non-3D-intensive applications, but you'll probably want to use a separate graphics card in the A480A7-VGF's PCI-E x16 slot for graphically demanding programs and gaming. There are two PCI-E x1 slots and three PCI slots to meet your future expansion needs.

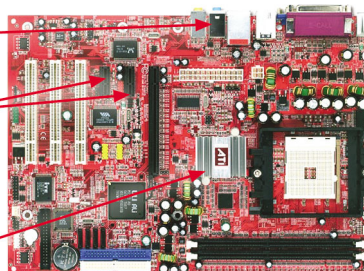
Four 1.5Gbps SATA ports let you combine your SATA hard drives in a RAID 0, 1, or 0+1 configuration. Two IDE connectors let you add up to four IDE devices.

In addition to the VGA port, four USB 2.0 ports, one IEEE 1394, and an RJ45 port for Gigabit Ethernet camp out on the A480A7-VGF's rear I/O panel. Audio enthusiasts will also find integrated S/PDIF output to accompany an 8-channel, high-definition ACL880 audio codec. ▲

S/PDIF

2 PCI-E X1 SLOTS

ATI RADEON XPRESS
200/ULI M1573 CHIPSET



Tul A480A7-VGF

Socket Type	Socket 754 AMD
Chipset	ATI Radeon Xpress 200, ULI M1573
Processor Support	Athlon 64
RAM Support	2GB DDR400/333/266
RAM Slots	2
Graphics Bus	1 PCI-E x16 slot
PCI Slots	3
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (1.5Gbps; RAID 0/1/0+1)
IDE	UDMA ATA 133
USB Ports	4, plus 4 optional (2.0)
FireWire Ports	1, plus 1 optional
LAN	Gigabit Ethernet
Integrated Audio	8-channel ALC880 codec, S/PDIF
Integrated Graphics	Radeon X300 series core
Other features	N/A
URL	www.tul.com.tw
Price	N/A

TYAN TOMCAT K8E

This NVIDIA nForce4 Ultra-based motherboard isn't going to give you SLI, but all the other goodies are there. The Tyan Tomcat K8E is a Socket 939 mobo that, in addition to AMD Athlon 64 and 64 FX CPUs, also supports new dual-core X2 processors. Like most Socket 939 mobos with NVIDIA's latest MCP, the Tomcat K8E supports unbuffered DDR400/333 SDRAM; there are four DIMM slots for a maximum 4GB RAM.

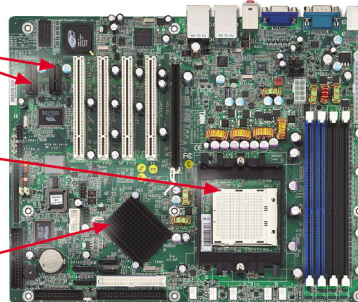
The Tomcat K8E gives you two options for video, depending on your needs. Hardcore gaming enthusiasts will certainly want to use the Tomcat K8E's PCI-E x16 slot to get the most out of their favorite games, but users who don't use graphics-intensive applications should be perfectly happy with the board's ATI RAGE XL integrated graphics controller.

Thanks to the nForce4 Ultra chipset, your brand-spanking new 3Gbps SATA hard drives will feel right at home with the Tomcat K8E. NVIDIA's NVRAID supports RAID 0, 1, and 0+1 for the board's four SATA headers.

Tyan also rolled out the red carpet for your peripherals, with support for up to eight USB 2.0 ports and two IEEE 1394a ports. Dual Gigabit Ethernet and an AC'97 codec are also along for the ride. ▲

PCI-E X1 SLOTS

SOCKET 939 AMD

NVIDIA NFORCE4
ULTRA CHIPSET

Tyan Tomcat K8E

Socket Type	Socket 939 AMD
Chipset	NVIDIA nForce4 Ultra
Processor Support	Athlon 64, 64 FX, X2
RAM Support	4GB Unbuffered DDR400/333
RAM Slots	4
Graphics Bus	PCI-E x16
PCI Slots	4
PCI-E Slots	2 PCI-E x1
SATA Ports	4 (3Gbps; RAID 0/1/0+1)
IDE	ATA 133
USB Ports	8 (2.0)
FireWire Ports	2 IEEE 1394a
LAN	Dual Gigabit Ethernet
Integrated Audio	Realtek ALC655; AC'97 codec
Integrated Graphics	ATI RAGE XL
Other features	nTune support
URL	www.tyan.com
Price	\$280

TYAN TOMCAT i7221A

The Tyan Tomcat i7221A isn't your traditional single-processor motherboard. Most Pentium 4 owners expect to see an Intel 9XX chipset on their motherboards, but the Tomcat i7221A sports Intel's E7221 (Copper River) + ICH6R + PXH-V chipset. But its ATX form factor makes it suitable for a desktop chassis. The LGA775 Socket supports Intel Pentium 4 processors with either an 800MHz or 533MHz. This mobo's four DIMM slots support up to 4GB unbuffered DDR400/333 memory.

Because this is an entry-level server board, don't expect flashy graphics. There are no PCI-E x16 or AGP slots on the board; the only graphics available at your disposal are courtesy of the 8-bit VGA DAC from the MCH. The real versatility lies with the Tomcat i7221A's various PCI slots. There are two PCI-E x1 slots, one PCI slot, and one PCI-X slot, so most expansion cards will fall under the Tomcat i7221A's umbrella.

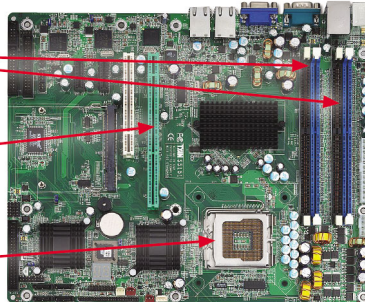
Networking is another one of the Tomcat i7221A's strengths. It has two Broadcom BCM5721 Gigabit Ethernet controllers operating at an x1 PCI-E interface and an Intel 82551 10/100 Ethernet LAN Controller.

Although you can set up a RAID 0 or 1 array using the Tomcat i7221A's four 1.5Gbps SATA headers, a built-in TARO SO-DIMM expansion port lets you add an additional SCSI or SATA RAID card. ▲

DDR

PCI-X SLOT

SOCKET 775 INTEL



Tyan Tomcat i7221A

Socket Type	Socket 775 Intel
Chipset	Intel E7221, ICH6R
Processor Support	P4 with EM64T
RAM Support	4GB DDR400/333
RAM Slots	4
Graphics Bus	Integrated graphics
PCI Slots	1 PCI, 1 PCI-X
PCI-E Slots	2 PCI-E x1 slots
SATA Ports	4 (1.5Gbps; RAID 0/1)
IDE	UDMA ATA / 100/66/33
USB Ports	4 (2.0)
FireWire Ports	N/A
LAN	Dual Gigabit Ethernet, Intel 82551 10/100 Ethernet
Integrated Audio	N/A
Integrated Graphics	VGA (8-bit DAC)
Other features	Adaptec AIC-7902/AIC-7901 dual-/single-channel Ultra320 SCSI controller (optional), Watchdog timer, port 80 code display LED
URL	www.tyan.com
Price	\$314

DDR2 Memory

Today's Top DDR2 Modules

When we published our last *PC Modder* issue, DDR2 was still relatively new. Although DDR2 still doesn't dominate the memory market, the new technology is gaining ground and the number of modules available has increased. In addition, you will also find higher frequencies, with PC2-8000 DDR2 now reaching 1GHz. The following charts list the DDR2 modules

available at press time. We've listed the CAS latency for all modules. When a manufacturer also provided the full timing settings, we included the additional information. (NOTE: For information on additional memory modules, see www.cpumag.com/pcmodder/ddr2.) **CPU**

Compiled by Kylee Dickey

DDR2-400 PC2-3200

Manufacturer	Model Product Number	Density	Latency	Registered	ECC	Voltage	Package
Buffalo	D2R400A-E1G	1GB	3	Registered	ECC	1.8V	240
Buffalo	D2R400A-ER1G	1GB	3	Registered	ECC	1.8V	240
Buffalo	D2R400A-E512	512MB	3	Registered	ECC	1.8V	240
Buffalo	D2R400A-ES512	512MB	3	Registered	ECC	1.8V	240
Buffalo	D2N533B-D512	512MB	4	Unbuffered	ECC	1.8V	240
Buffalo	D2R400A-ES256	256MB	3	Registered	ECC	1.8V	240
Buffalo	D2N533B-X256	256MB	4	Unbuffered	ECC	1.8V	240
Kingston	KVR400D2D8R3K2/4G	4GB (2GB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2D4R3K2/4G	4GB (2GB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2S4R3K2/4G	4GB (2GB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2D8R3K2/2G	2GB (1GB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2R3K2/2G	2GB (1GB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2N3K2/2G	2GB (1GB x 2)	3	Unbuffered	Non-ECC	1.8V	240 (x2)
Kingston	KVR400D2D4R3/2G	2GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2S4R3/2G	2GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2D8R3/2G	2GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2D4R3/2GI	2GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2R3K2/1G	1GB (512MB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2S8R3K2/1G	1GB (512MB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2S4R3K2/1G	1GB (512MB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2E3K2/1G	1GB (512MB x 2)	3	Unbuffered	ECC	1.8V	240 (x2)
Kingston	KVR400D2N3K2/1G	1GB (512MB x 2)	3	Unbuffered	Non-ECC	1.8V	240 (x2)
Kingston	KVR400D2S4R3/1GI	1GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2D8R3/1G	1GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2R3/1G	1GB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2N3/1G	1GB	3	Unbuffered	Non-ECC	1.8V	240
Kingston	KVR400D2R3K2/512	512MB (256MB x 2)	3	Registered	ECC	1.8V	240 (x2)
Kingston	KVR400D2N3K2/512	512MB (256MB x 2)	3	Unbuffered	Non-ECC	1.8V	240 (x2)
Kingston	KVR400D2R3/512	512MB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2S4R3/512	512MB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2S8R3/512I	512MB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2S8R3/512	512MB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2E3/512	512MB	3	Unbuffered	ECC	1.8V	240
Kingston	KVR400D2N3/512	512MB	3	Unbuffered	Non-ECC	1.8V	240
Kingston	KVR400D2R3/256	256MB	3	Registered	ECC	1.8V	240
Kingston	KVR400D2E3/256	256MB	3	Unbuffered	ECC	1.8V	240
Kingston	KVR400D2N3/256	256MB	3	Unbuffered	Non-ECC	1.8V	240
Kingston	KVR400D2S3/1G	1GB	3	Unbuffered	Non-ECC	1.8V	200
Kingston	KVR400D2S3/512	512MB	3	Unbuffered	Non-ECC	1.8V	200
Kingston	KVR400D2S3/256	256MB	3	Unbuffered	Non-ECC	1.8V	200
Kingston	KVR400D2S3/128	128MB	3	Unbuffered	Non-ECC	1.8V	200

DDR2-675 PC2-5400

Manufacturer	Model Product Number	Density	Latency	Registered	ECC	Voltage	Package
Corsair	TWIN2X1024A-5400UL	1GB (512MB x 2)	3-3-2-8	Unbuffered	Non-ECC	2.1V	240 (x2)
Corsair	TWIN2X1024-5400C4	1GB (512MB x 2)	4-4-4-12	Unbuffered	Non-ECC	1.9V	240 (x2)
Corsair	TWIN2X1024-5400C4PRO	1GB (512MB x 2)	4-4-4-12	Unbuffered	Non-ECC	1.9V	240 (x2)
Corsair	TWIN2X512-5400C4	512MB (256MB x 2)	4-4-4-12	Unbuffered	Non-ECC	2V	240 (x2)
Corsair	CM2X512A-5400UL	512MB	3-3-2-8	Unbuffered	Non-ECC	2.1V	240
Corsair	CM2X512-5400C4PRO	512MB	4-4-4-12	Unbuffered	Non-ECC	1.9V	240
Corsair	CM2X256-5400C4	256MB	4-4-4-12	Unbuffered	Non-ECC	2V	240
GeIL	GX22GB5300SDC	2GB (1GB x 2)	3-4-4-8	Unbuffered	Non-ECC	1.8V-2.4V	240 (x2)
GeIL	GX21GB5300SDC	1GB (512MB x 2)	3-4-4-8	Unbuffered	Non-ECC	1.8V-2.4V	240 (x2)
GeIL	GX21GB5300SX	1GB	3-4-4-8	Unbuffered	Non-ECC	1.8V-2.4V	240
GeIL	GX25125300SX	512MB	3-4-4-8	Unbuffered	Non-ECC	1.8V-2.4V	240

DDR2-667 PC2-5400

OCZ Technology	OCZ26672048EBDCTE-K	2GB (1GB x 2)	4-2-2-8	Unbuffered	Non-ECC	2.1V	240 (x2)
OCZ Technology	OCZ26672048EBDCPE-K	2GB (1GB x 2)	4-2-2-8	Unbuffered	Non-ECC	2.1V	240 (x2)
OCZ Technology	OCZ26672048ELDCGE-K	2GB (1GB x 2)	4-4-4-8	Unbuffered	Non-ECC	1.8V	240 (x2)
OCZ Technology	OCZ26772048PFDC-K	2GB (1GB x 2)	4-4-4-8	Unbuffered	Non-ECC	1.8V	240 (x2)
OCZ Technology	OCZ26671024EBDCPE-K	1GB (512MB x 2)	4-2-2-8	Unbuffered	Non-ECC	2.1V	240 (x2)
OCZ Technology	OCZ26671024EBDCTE-K	1GB (512MB x 2)	4-2-2-8	Unbuffered	Non-ECC	2.1V	240 (x2)
OCZ Technology	OCZ26671024ELDCGE-K	1GB (512MB x 2)	4-4-4-8	Unbuffered	Non-ECC	1.8V	240 (x2)
OCZ Technology	OCZ26671024PFDC-K	1GB (512MB x 2)	4-4-4-8	Unbuffered	Non-ECC	1.8V	240 (x2)
OCZ Technology	OCZ26671024EBPE	1GB	4-2-2-8	Unbuffered	Non-ECC	2.1V	240
OCZ Technology	OCZ26671024EBTE	1GB	4-2-2-8	Unbuffered	Non-ECC	2.1V	240
OCZ Technology	OCZ26671024ELGE	1GB	4-4-4-8	Unbuffered	Non-ECC	1.8V	240
OCZ Technology	OCZ26671024PF	1GB	4-4-4-8	Unbuffered	Non-ECC	1.8V	240
OCZ Technology	OCZ2667512PFDC-K	512MB (256MB x 2)	4-4-4-8	Unbuffered	Non-ECC	1.8V	240 (x2)
OCZ Technology	OCZ2667512EBTE	512MB	4-2-2-8	Unbuffered	Non-ECC	2.1V	240
OCZ Technology	OCZ2667512EBPE	512MB	4-2-2-8	Unbuffered	Non-ECC	2.1V	240
OCZ Technology	OCZ2667512ELGE	512MB	4-4-4-8	Unbuffered	Non-ECC	1.8V	240
OCZ Technology	OCZ2667512PF	512MB	4-4-4-8	Unbuffered	Non-ECC	1.8V	240
OCZ Technology	OCZ2667256PF	256MB	4-4-4-8	Unbuffered	Non-ECC	1.8V	240
PQI	PQI25400-1GDB	1GB (512MB x 2)	4-4-4-12	Unbuffered	Non-ECC	2V	240 (x2)
PQI	MAC41GUOE	1GB	5	Unbuffered	Non-ECC	2V	240
PQI	PQI25400-512DB	512MB (256MB x 2)	4-4-4-12	Unbuffered	Non-ECC	2V	240 (x2)
PQI	PQI25400-512SB	512MB	4-4-4-12	Unbuffered	Non-ECC	2V	240
PQI	MAC412UOE	512MB	5	Unbuffered	Non-ECC	2V	240
PQI	PQI25400-256SB	256MB	4-4-4-12	Unbuffered	Non-ECC	2V	240
PQI	MAC456UOE	256MB	5	Unbuffered	Non-ECC	2V	240

DDR2-800 PC2-6400

Corsair	TWIN2X1024A-6400	1GB (512MB x 2)	5-5-5-12	Unbuffered	Non-ECC	1.9V	240 (x2)
Corsair	CM2512A-6400	512MB	5-5-5-12	Unbuffered	Non-ECC	1.9V	240
Mushkin	991473	2GB (1GB x 2)	5-3-3-8	Unbuffered	Non-ECC	1.9V-2.1V	240 (x2)
Mushkin	991472	1GB (512MB x 2)	5-3-3-8	Unbuffered	Non-ECC	1.9V-2.1V	240 (x2)
Mushkin	991471	1GB	5-3-3-8	Unbuffered	Non-ECC	1.9V-2.1V	240
Mushkin	991470	512MB	5-3-3-8	Unbuffered	Non-ECC	1.9V-2.1V	240
OCZ Technology	OCZ28002048ELDCGE-K	2GB (1GB x 2)	5-5-5-10	Unbuffered	Non-ECC	1.9V	240 (x2)
OCZ Technology	OCZ28001024EBDCPE-K	1GB (512MB x 2)	4-3-3-8	Unbuffered	Non-ECC	2.1V	240 (x2)
OCZ Technology	OCZ28001024ELDCGE-K	1GB (512MB x 2)	5-5-5-10	Unbuffered	Non-ECC	1.9V	240 (x2)
OCZ Technology	OCZ28001024EBPE	1GB	4-3-3-8	Unbuffered	Non-ECC	2.1V	240
OCZ Technology	OCZ28001024ELGE	1GB	5-5-5-10	Unbuffered	Non-ECC	1.9V	240
OCZ Technology	OCZ2800512ELGE	512MB	5-5-5-10	Unbuffered	Non-ECC	1.9V	240

DDR2-1024 PC2-8000

Corsair	TWIN2X1024-8000UL	1GB (512MB x 2)	5-4-4-9	Unbuffered	Non-ECC	2.2V	240 (x2)
Corsair	CM2512-8000UL	512MB	5-4-4-9	Unbuffered	Non-ECC	2.2V	240
OCZ Technology	OCZ210001024ELDCPE-K	1GB (512MB x 2)	5-5-5-15	Unbuffered	Non-ECC	2.1V	240 (x2)
OCZ Technology	OCZ210001024ELPE	1GB	5-5-5-15	Unbuffered	Non-ECC	2.1V	240

Modding Q & A

Tackle Your Modding Trouble

Although you'll get a rush when you push your processor to an unbelievable clock speed and then watch Windows boot up, you'll also spend plenty of time staring at a blank screen. Overclockers and modders often spend half of their project time trying to overcome unexpected obstacles. Some of these problems are exciting—I occasionally see a smoking computer in our lab, but most of the time the problems are just painful. Here are a few tips to overcome modding and overclocking issues.

(NOTE: When you modify or overclock your computer components, you'll void their warranties and potentially damage them beyond repair. Keep your own safety and the safety of your computer in mind when modding and overclocking.)

Q I used a pair of aluminum nibblers to cut out a case window that had rounded corners. The nibblers tore up these new window edges—I don't want to use rubber molding strips to cover the nasty edges, but I can't ignore the jagged cuts. How can I clean up my window?

A Manual and power nibblers, which generally use three massive teeth to chew through aluminum, give users a lot of control over speed and accuracy. They also round corners easily, while rotary tools make for better straight line cuts. That's not to say that rotary tools can't handle rounded corners at all: They can, but I'm not surprised you chose the nibbler device when cutting your case window's simple, rounded edges.

Unfortunately, nibblers don't cut as cleanly as rotary tools, which slice right through aluminum case panels, leaving rough-but-manageable edges behind. Even after you wear the fresh edges into harmless, rounded win-

dow borders, you'll probably find teeth marks around the cut. (Rubber molding generally covers this up.) And to top things off, you'll need to use a rotary tool to clean up the aftermath of the nibbler's bite.

So, you've got your rotary tool—how do you smooth those nibbled edges? "The perfect accessory for this job is one of our Aluminum Oxide Grinding Stones," says Gavin Jerome, accessory product manager at Dremel.

Jerome recommends the cylindrical head (model 932), which is small but tougher than it looks. According to Jerome, most retail Dremels include a 932 Aluminum Oxide bit, but it may not have the 932 bit cylindrical shape, which lends itself to this type of task. "The bit will remove the rough edges and smooth the metal to a safe edge," says Jerome. If you're about to start this project, don't panic: Dremel bits are available in hardware stores and online for about \$5.



You can clean up sharp edges by popping a grinding stone into your rotary tool. This is a Dremel 8193 aluminum oxide head.

(And if you don't have one already, you'll want to pick up a 480 or 585 collet, as either secures the bit to the drill.)

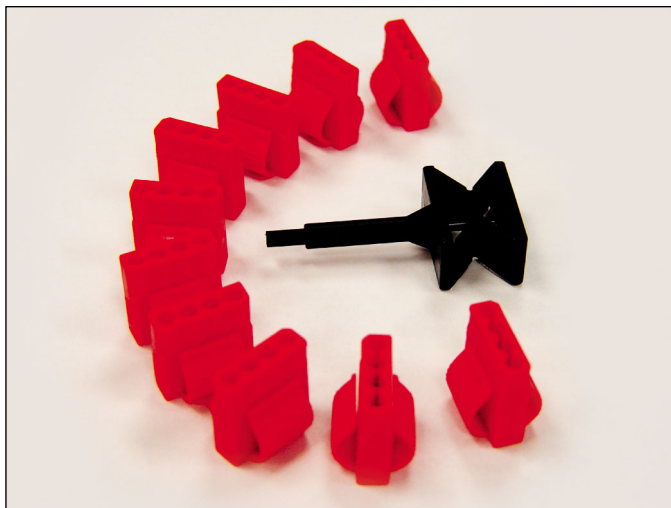
You should begin the process by grinding down parts that are particularly sharp, Jerome notes. You'll spot the dangerous areas right away when you look at one side of the case or side panel, but don't forget to check the other side of the cut: Nibblers sometimes twist aluminum hangnails downward. After you grind down the particularly nasty areas, you can smooth the rest of the cut's sharp edges by running the grinding stone along the length of the edge. "Moving the bit along the length of the metal is recommended but moving it up and down is also fine," says Jerome.

Q Thanks to a window and some hot, high-end components, a tidy case is particularly important to me. I want to sleeve my power supply's messy cables, but my new sleeving doesn't fit over the PSU connectors. How do I remove and then reattach the connectors?

A Believe it or not, power supply cable connectors (the 12V, 4-pin versions are often referred to by the popular brand name Molex) aren't permanent fixtures. As PSU mods go, popping the pins out of those little plastic connectors is by far the easiest project—provided you have the right tools. You'll need to invest in modding tools whether you plan to cut the connectors off and replace the pins (in which case you'll need a soldering tool) or simply remove the pins.

If you have one of those multitool computer kits that flood into techie homes as gifts during the holidays, double-check it before you head to online retailers. You're looking for a device that resembles a syringe; most have a thin

Why put the same old white connectors back on your PSU cables? Accessory manufacturers, such as Logisys, offer tons of colorful connectors that spice up your case.



tip and a plunger on the other end. Unfortunately, only one tool isn't enough: You'll need to get a kit or universal tool. Some PSU connectors have male pins and others have female pins, each of which requires a different type of tool. Another must-have is the 12v ATX connector pin remover, which handles the connector that powers the motherboard. Most pin extractor tools cost less than \$10, but they add up quickly, so keep an eye out for tool kits or universal tools.

When you're ready to extract the pins, grab the nearest 4-pin connector, slide it over the pin (and brace the connector with your other hand) and then push the plunger inward until the pin pops out. You'll need to pop each individual pin and then keep track of the loose wires. The 12v extractor, which handles the 20-pin motherboard connector, trades the standard syringe body for a tweezers-like shape that lets you retract hooks on the outside of the pin. Once you push the hooks inwards, you can slide the connector off the pins.

Once you've sheathed the cables with the sleeving, you'll need to replace the plastic PSU connectors. Keep a pair of needle-nose pliers handy as you need to extend each pin's hooks before wedging it back into the connector. (If the pin bends during the process, you can also use the pliers to straighten the pin.) Keep in mind that you don't need to stick with the white or black plastic connectors that you just removed—most modding supply

retailers offer a selection of colored and UV connectors that might compliment your rig's color theme better than standard connectors.

Q I've heavily modded my system and have already included all the fans I need in my system. Unfortunately, I didn't pay much attention to noise in my quest for power and aesthetic appeal: The rig sounds like a wind tunnel. How can I reduce fan noise without replacing any of my system's fans?

A If you had planned ahead, you could have bought fans that have manual or automatic speed controls. You could also have bought quiet fans—manufacturers are falling over themselves to provide quiet air cooling as users cram more hot components than ever into outdated chassis designs. But now that you've already built your system, you can lower the noise level without unscrewing your array of case fans.

If you have an empty 5.25-inch or 3.5-inch bay handy, consider a bay fan controller or rheobus, both of which generally

slide into a 5.25-inch bay slot and sport multiple dials that let you control individual fans. The devices are similar and many modders use the terms interchangeably, but manufacturers often use the "fan controller" label when promoting a device that has two or three settings (On, Off, Slow, for example) and use "rheobus" to designate devices that give users complete control over fan speed. Both devices generally sport dials.

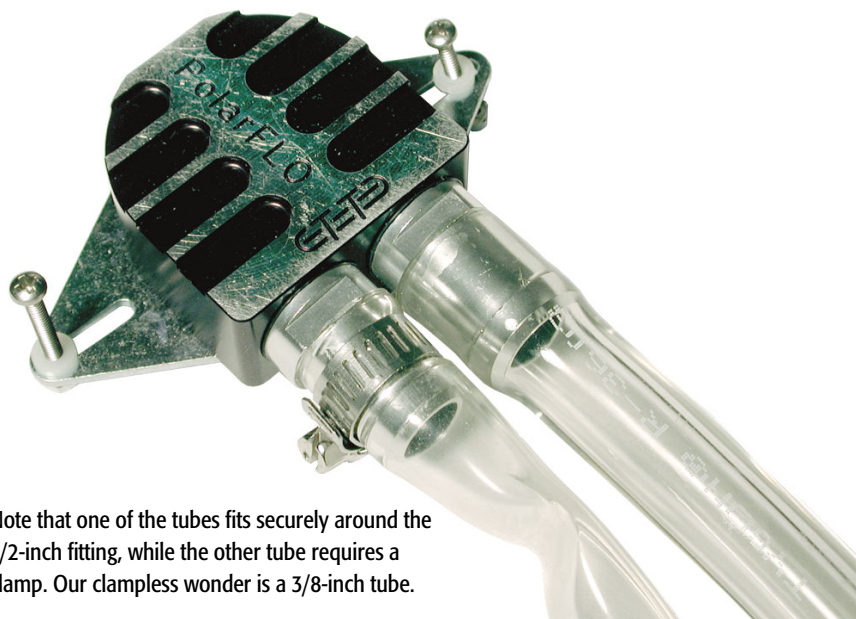
Head to your favorite online computer retailer, and you'll probably find a half-dozen fan controllers, but specialty retailers that target computer enthusiasts have the largest selections: FrozenCPU.com, for example, boasts about 45 fan control options, many of which are bay fan controllers. Some fan controllers include 4-pin connectors that let you attach your 4-pin case fans. Others have the smaller 3-pin connectors, and some sport both connector types. You'll need to plug the fans directly into the fan controller, which means that fans near the back of the case will probably need longer cords. Luckily, online retailers offer a slew of extension cables and even 3-to-4 pin adapter cables.

If you don't want to bother with the fans whenever you switch applications, you'll need an automatic fan controller. These devices are more expensive, but they often have perks: Some manufacturers cram extra components into the fan controller. Sunbeam's 20-in-1 Superior Panel, for example, includes controls for two fans, two temp sensors, USB 2.0 ports, audio ports, and several media card slots. To top it off, the device includes a small display that offers temps, the time, and other data.

Q I built my watercooling system with standard components, including hose clamps. I'm having



Take control of your fans with a fan controller. This Vantec NXP-301 plugs into your 5.25-inch bay and lets you adjust fan speeds and case lighting.



Note that one of the tubes fits securely around the 1/2-inch fitting, while the other tube requires a clamp. Our clampless wonder is a 3/8-inch tube.

trouble with water leaking from one of the tubes that connects to the waterblock fitting. How can I stop the leakage?

A Chances are, you haven't adequately tightened the hose clamp. Hose clamps force the tube against the fitting to create a watertight seal. If you transport your system (carry it, or worse, drive with it), the multiple jolts might loosen poorly attached clamps. Turn off your computer and remove the power cable, then double-check the clamp or, if you have an extra clamp handy, replace the suspect fastener.

manufacturers match 1/2-inch tubing to 1/2-inch fittings (the tube connectors on watercooling items, such as pumps and waterblocks) when building kits. But, as Stephens points out, the large tubing doesn't determine the water flow so much as the fittings because they have slightly smaller holes. In fact, the inner diameter of a 1/2-inch fitting is 3/8 of an inch, which is the inner diameter of 3/8-inch tubing. When 3/8-inch tubing attaches to 1/2-inch fittings, the water flows freely through the system without hitting any bottlenecks.

water and wipe the tubing quickly to remove any drops. Immediately slide the tube over the fitting. You'll find that the tube is very flexible now and easily expands when you push it onto the metal fitting, but don't rush the job—you can damage the tubing if you're not careful. Finally, let the tubing cool. As it cools, the tube's end will retract against the fitting, creating a water-tight seal.

The method has a catch—once the tube cools, you can't pull it off. You'll need to cut the tubing if you need to replace it later, but, as Stephens notes, the pros outweigh the cons. "The pros to doing this are: garmented seal so no leaks, no hose clamps so no extra cost, no hose clamps means a cleaner looking system, the 3/8-inch tubing costs less, you don't lose any flow because the ID (inside diameter) of the tubing is the same as the ID on the fittings," Stephens says.

Q I want to airbrush my notebook, which has a plastic chassis. I've heard that paint doesn't dry well on plastic surfaces and peels easily. How can I ensure that my artwork lasts?

A Many modders suggest sanding. The sandpaper scuffs up the plastic, creating an abrasive surface that can better grab the paint. Modders who use this technique generally sand the plastic and

Custom Painting

Many modders suggest sanding. The sandpaper scuffs up the plastic, creating an abrasive surface that can better grab the paint.

Some modders shun hose clamps completely in favor of a technique that requires more effort but provides a super-tight seal. "A very good way to seal the tubing to the fittings is to use smaller tubing than the fittings," says Dan Stephens, owner and VP of sales and marketing of the popular Danger Den (www.dangerden.com) watercooling equipment manufacturer.

His advice contradicts standard watercooling wisdom—most watercooling

Of course, 3/8-inch tubing won't slide over a 1/2-inch fitting right away. Stephens recommends the boiling water technique: Attach the waterblocks, pump, radiator, and other equipment to your computer and then measure and cut your tubing. Next, boil water (carefully) nearby and then dip one end of the tube into the boiling water. Stephens suggests holding it in the boiling water for at least 15 seconds. Next, pull the tubing from the

then wet sand in between coats of paint. To wet sand, grab a soft sanding tool (such as a rubber sand block), wrap the sandpaper around it, and then soak it in a bucket. If you plan to try this method, invest in several types of sandpaper. Manufacturers rate their paper's abrasiveness by grit: Larger numbers mean a finer grit, which provides a smoother sanding job than the abrasive, low-grit papers. You can start with a low grit and then

work your way toward finer grits as you apply more layers of primer and paint.

Sanding is a particularly slow technique that doesn't guarantee a lasting paintjob, so we talked to Jim Saling, owner of Smooth-Creations (www.smoothcreations.com) to find out how his company handles plastic. The custom painter has built a reputation painting desktop and notebook cases and even gaming consoles and iPods. The company also handles Hyper-sonic PC's (www.hypersonic-pc.com) airbrushing needs.

Not surprisingly, Smooth-Creations doesn't bet on sanding when it starts a project. "With plastics you're not looking for a mechanical scratch but chemical adhesion," Saling says. "What most people don't know is that you can sand and sand and your paint still peels off."

Saling recommends buying an adhesion promoter that supports your computer's plastic type. The promoter creates a fine adhesive layer that grips both the plastic and the paint, locking the image to your computer. You can check for the plastic's type by looking for a light stamp somewhere on the inside of the chassis. "ABS (Acrylonitrile Butadiene Styrene) is the most common," says Saling. "PP (polypropylene) is also used in the industry often." Be sure to clean the plastic before applying the adhesion agent. "Washing with warm soapy water and a plastic cleaner helps remove mold release agents," says Saling.

Q I need to bend acrylic but don't have the time or patience to order a custom piece. Can I just shape a piece myself?

A Yes you can, assuming you plan to make a straight bend across a sheet of acrylic. The clear, stiff material softens in high temperatures, which means you can alter an acrylic sheet by heating it, shaping it, and then letting it cool. (The acrylic solidifies as it cools.) Of course, heating the entire sheet makes the entire

sheet pliable and difficult to control, so many modders rely instead on the strip heater, a relatively simple device that plugs into a standard home wall outlet. Consumer strips are generally low-wattage (50 to 80W) devices, but they can reach up to 280 degrees F in a few minutes. This temperature is plenty hot enough to melt a thin, long strip of the acrylic sheet. Note that ovens and other closed heaters are off limits; the acrylic emits gasses as it heats up and the trapped gases can explode.

If you plan to replace the sides and top of your PSU's boring metal enclosure with a clear chassis, for example, you can create a U-shaped cover from a long



This Craftics strip heater creates a straight, malleable strip across your acrylic sheet. The strip is hot, but it's less dangerous (for the acrylic and you) than an open flame.

acrylic sheet by melting it twice with a strip heater—once per corner. Bend the acrylic sheet away from the strip heater, unless the sheet is particularly thick, in which case you may need to heat both sides of the bend area. The acrylic won't cool for a few minutes, which means you'll need to secure the acrylic sheet until it stiffens.

You can hold the two ends of the sheet in place, but you can create smoother bends by creating a mold first. If you need to make a 90-degree bend, for example, you can use wood planks and a wood block. Nail the wooden planks into a 90-degree mold, then place the freshly-bent acrylic sheet into mold. Finally, place the

wooden block on the acrylic sheet and wedge it into the corner.

If, on the other hand, you want to create a container, such as a reservoir for your watercooling kit, you'll probably find yourself cutting and gluing acrylic. Although acrylic is much more scratch-resistant than some other clear materials, such as Lexan, it breaks easily, which means you'll need to be sure you have the right tools when you cut or drill. Some computer enthusiast retailers offer entire sets (which cost more than \$85) of acrylic-specific drill bits, but you can find individual drill bits for a fraction of the cost.

Once you cut acrylic into the appropriate shapes, you can smooth rough-cut edges with a file or sandpaper. Push the smoothing tool in a single direction. Keep in mind that the paper attached to most retail acrylic sheets reduces scratching—you'll probably prevent more than a few dings by leaving the paper on until you finish the project.

"For cutting rounded corners on a rectangle window, my best tool for that is the forstner bit I have for the drill press," says Greg Lindley, an experienced modder. "For cutting rounded holes in general, I probably like the hole cutter better because you can almost see 'through' it while it is cutting. I also like it [the hole cutter] because it looks like it can cause some pretty wicked injuries if you don't pay attention," Lindley says.

Attaching acrylic pieces is a tricky feat, as most glues won't secure the material. When Lindley isn't looking for a waterproof seal, he drills holds into the joints and then secures the joints with screws. This technique holds the pieces in place just fine without require any messy materials. If you need a watertight seal,

however, you'll need to glue the joints. Look for glues designed for acrylic. This capillary cementing glue is thin and can create a mess in seconds, but if you're careful, you can easily run it along the edges. (Make sure you have a tight fit, as the water-like glue won't fill in gaps well.)

Q I didn't pay much attention to my reservoir's location while building and modding my computer. Now I can't easily reach it to refill or flush the watercooling system. Can I create a more easily-accessed fluid entry point?

A If your reservoir has an extra port, or if you have a T connector handy, you're in luck. Danger Den has a watercooling component, the fill port, which lets you refill your system without reaching inside the computer chassis. The fill port is a small device that plugs into one of the system's tubes via a standard 1/2-inch or 3/8-inch diameter fitting. The top portion of the fill port attaches to the top of your computer. (You can also attach it to a side panel.) To fill your watercooling system, you insert a hex wrench into the top of the fill port, remove the plug, and then pour the fluid into the port.

Unlike most watercooling components, which generally sit inside your system, the fill port requires some minor case cutting: You'll need to cut a small hole in the top



If you've ever spilled liquid into your computer while filling the reservoir, this device is for you. The fill port lets you pour liquid without opening your case.

Q I've seen modded hard drives online that have near-mirror finishes. I wet sanded the sticker off my drive and then sanded the drive's metal for half an hour, but I'm not seeing my reflection. Why not?

A Before I go any further, I'd like to point out that hard drives are extremely fragile. You may well ruin your hard drive during this process, and you'll certainly void the drive's warranty, so don't continue if you can't afford to lose the drive. A 10,000rpm Western Digital Raptor is a terrible training drive. Also, it's a good idea to wait to start this

removing the sticker the old-fashioned way: Use your fingernails or a knife to work the label free. Start at a corner (or any raised edge if you spot one) and pull the sticker off slowly—if you're careful, you won't face much residue when you finally remove the last pieces of the sticker.

Gert Swolfs, the well-known modder who created Hypercube² (which graced the July 2005 cover of *CPU* magazine), used acetone to remove the last traces of sticker residue from the Hypercube²'s hard drives. "I experimented with different solutions like White Spirit, ether, rubbing alcohol and acetone," Swolfs says. "I found that acetone was the best pick for the job."

Be careful when you choose the material you'll use to rub the acetone into the residue—particularly rough sponges may scratch the surface of the drive. Swolfs used a swab to handle sensitive areas. You can avoid leaking acetone into the hard drive by pouring it on the cloth or cotton swab first and then applying the item to the drive.

Your second mistake was to start polishing the hard drive with the sander. Although power sanders make great scratch removal tools, they're generally not necessary when you polish your hard drives. Keep in mind that you're working on one of the more sensitive components in your system—if you use sandpaper at

Hard Drive Modding

Hard drives are extremely fragile.

You may well ruin your hard drive during this process, and you'll certainly void the drive's warranty, so don't continue if you can't afford to lose the drive.

of the case and then drop the fill port in from above so that the fill port's lip rests on the top of the case.

If you're connecting watercooling tubes via the boiling method described in this Q&A, be sure to insert the fill port through the top of the computer before you permanently attach the tube. Finally, run the tube to your reservoir's extra port or your T connector.

project until you have several free hours ahead of you.

You're making two mistakes that prevent your hard drive from showing off its shiny side. The first mistake was sanding off the manufacturer sticker—most hard drive stickers won't detach from the drive without leaving a clear, gummy residue. Instead of grinding through the label with a sander, you're probably better off

all, you'll probably want to sand the drives by hand. The fewer jolts and shocks the drive encounters during the process, the better.

Once you've removed the sticker and residue from the drive, apply some polish (Swolfs uses chrome automotive polish) to the surface and then rub it with a stiff, but not scratchy, scrubbing pad. (Watch out for scrubbing pads that

have metal fibers.) Put some elbow grease into it, then wipe the polish off and start again. The drive will appear shinier as you continue to repeat the cycle. You can also increase the shine by rubbing the hard drive with a clean cloth.

6800 Ultra, so if you find yourself troubleshooting a PC without spare parts, don't panic: Head to your local electronics or home improvement store and pick up a PSU tester.

In our experience the power supply blows more often due to overclocking

crash the computer sporadically (especially when the computer is handling benchmarks and other heavy-load applications) as a precursor to giving out completely. If you're not sure whether your power supply is sending the correct voltage to your motherboard and other

Overclocking

You can easily damage your computer or injure yourself by touching the prongs to the wrong pin.

Swolfs ditched the standard hand-scrubbing technique in favor of a Dremel and the buffing head, but he quickly encountered stripes in the metal and had to sand the drive for hours to return the drive to its shiny self. If you find yourself breaking out the sandpaper, start with medium grit. (Swolfs started with 800 grit and slowly worked his way up to 1600 grit.) Be sure to wet sand the device, but be careful—you don't want water dripping into the drive.

Q: The other day my overclocked computer suddenly powered off. I was able to power the system back on again a minute later, but now it crashes sometimes during video games and benchmarks. I probably hurt something, but I'm not sure what. How do I find the damaged component?

A (NOTE: As with so many computer projects, this project is risky: You can damage your computer by leaving the PSU tester attached too long. Please read any directions that accompany a PSU tester. This project is not for kids or anyone who has a tendency to become the least bit distracted.)

If you have spare parts or a (very patient) friend's computer, you can probably hunt down the problem pretty quickly by swapping out components. Start by returning your motherboard's BIOS to default settings and then narrow your list of suspects, one item at a time. That said, even the best of friends may be reluctant to hand over her prize GeForce

stress than any other component. The second most likely culprit is the motherboard. (Despite being so physically fragile, most of our CPUs live through their overclocking ordeals.) We've also noticed that faulty or damaged PSUs sometimes



PSU testers give working/not working results, but if you're looking for spot-on accuracy, you'll need to invest in a multimeter. You can buy inexpensive multimeters, but if you want extra features, consider a high-end device. This Fluke 110 (www.fluke.com) is very accurate and costs about \$399.

components, investing in a PSU tester is worth your time and money.

You can also test the PSU with a multimeter, which is generally more expensive than a PSU tester. Many multimeters have small displays that show the pin's exact voltage, but you can easily damage your computer or injure yourself by touching the prongs to the wrong pin. You're simply checking your PSU to make sure it's not the problem, so I suggest using a standard PSU tester, which will do just that. The tester plugs right into your PSU connector and uses LEDs to indicate normal or incorrect voltages. Some testers are better than others, so shop around: You'll find that some testers test only one type of connector (the 20-pin motherboard connector, for example) while others will also test 4-pin and 3-pin connectors.

After The Dust Settles

Hopefully these tips will help you work through the latest modding or overclocking problem, but don't assume that you're free and clear now that you've passed the first hurdle. You'll run into hundreds of computer quirks over the years. Modding requires patience, and sometimes a little help. Experienced modders remember the hours they spent troubleshooting problems, and they pass their hard-learned knowledge to the waves of newbies who appear on modding forums daily. Don't forget to share that wealth of knowledge. **CPU**

by Joshua Gulick

The Apple Doesn't Fall Far From The Tree

ZapWizard's Fully Functional Wooden iPod Mod

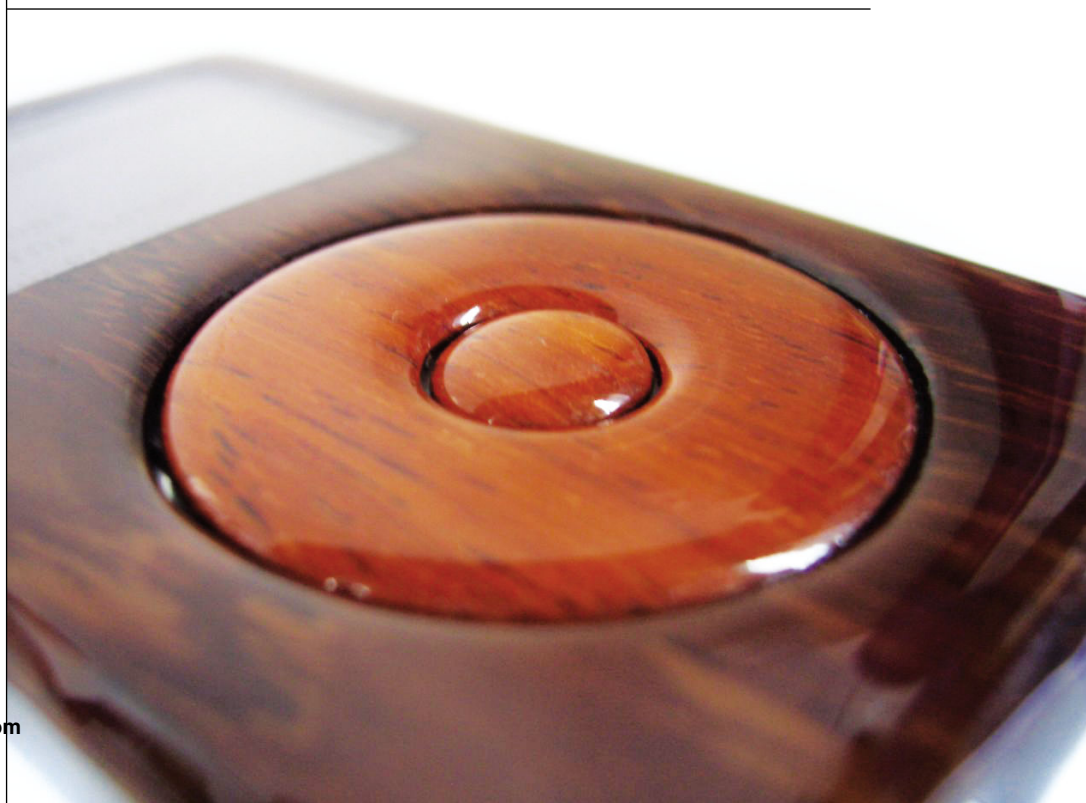
Joshua Driggs, also known as ZapWizard, has a reputation for creating eye-catching mods. His latest work is an iPod encased in real African Padauk wood. He started with a 20GB 4G iPod and designed a new faceplate, click wheel, and button using a Dremel rotary tool. The surface was covered with three coats of Envirotex Lite, giving it the same polished appearance of the iPod's original faceplate. Believe it or not, the reassembled iPod is fully functional. Even the wooden click wheel is touch-sensitive, just like the original. You can find details about the Wood iPod, as well as ZapWizard's other mods at www.zapwizard.com. **CPU**

Compiled by Kylee Dickey
Graphics & Design
by Fred Schneider

Eventually, the black dock will fit inside a not-yet-built wooden cover.



Gorilla Glue repaired a few cracks that resulted from carving the faceplate down to an extremely thin 2mm.



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Form and functionality collide with style in the NexStar external enclosure series from Vantec. Whether you need to have your data on the go or simply want an easy way to add drives to your computer, NexStar is the solution for you. Supporting hard drives or optical drives with USB or Firewire interfaces, there is a NexStar that will work with almost any hardware configuration. Offering speeds of up to 480 Mbps for USB 2.0 and 400 Mbps for Firewire, a NexStar external enclosure is an ideal way to store and transfer large amounts of data. Available in multiple designs and colors, the NexStar series lets you manage your data in an enclosure that matches your style!



TigerDirect.com

ZipZomfly.com

Micro Center

Fry's Electronics Outpost.com

For more information on where to buy, please go to

<http://www.vantecusa.com/wheretobuy.html>

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